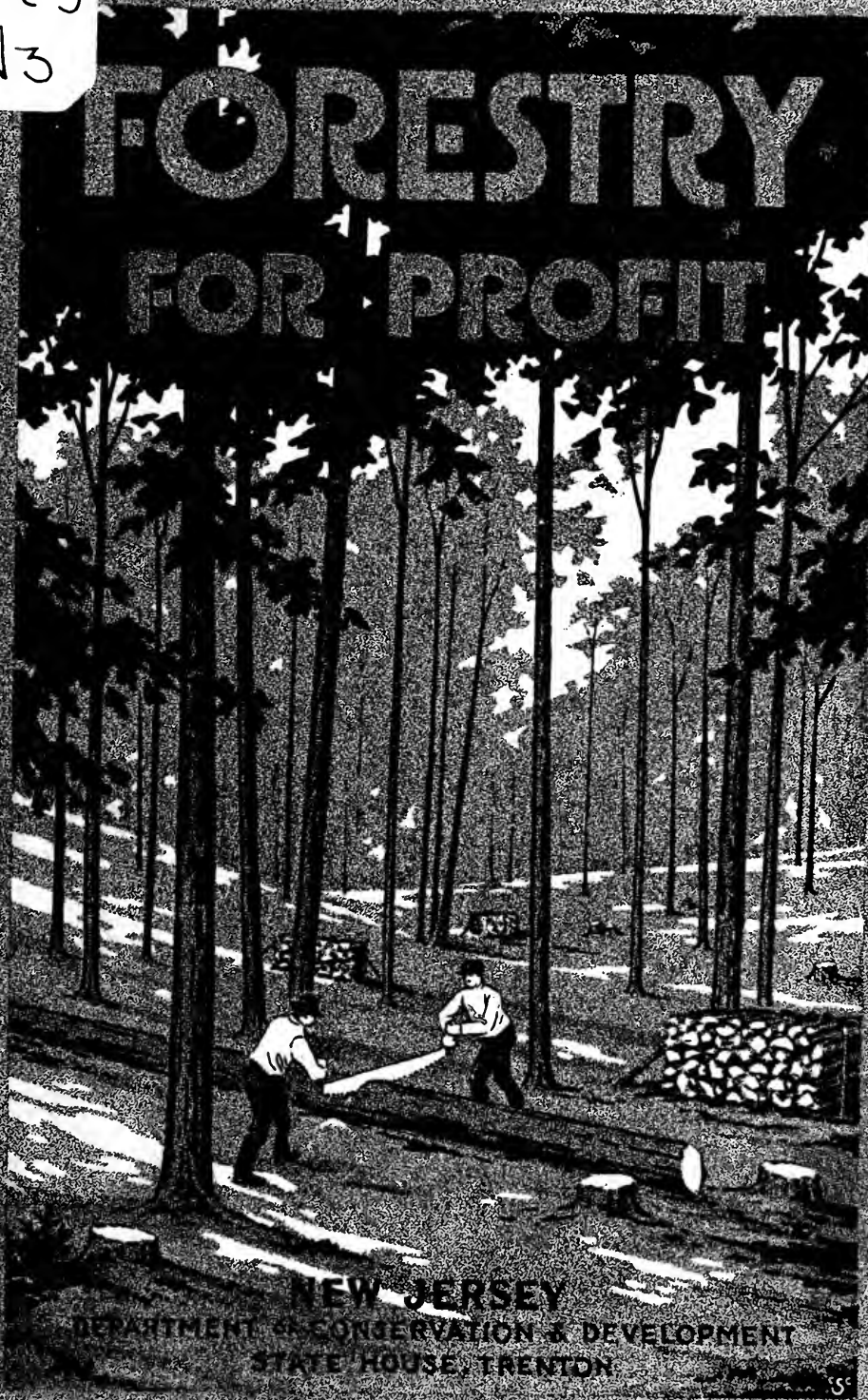
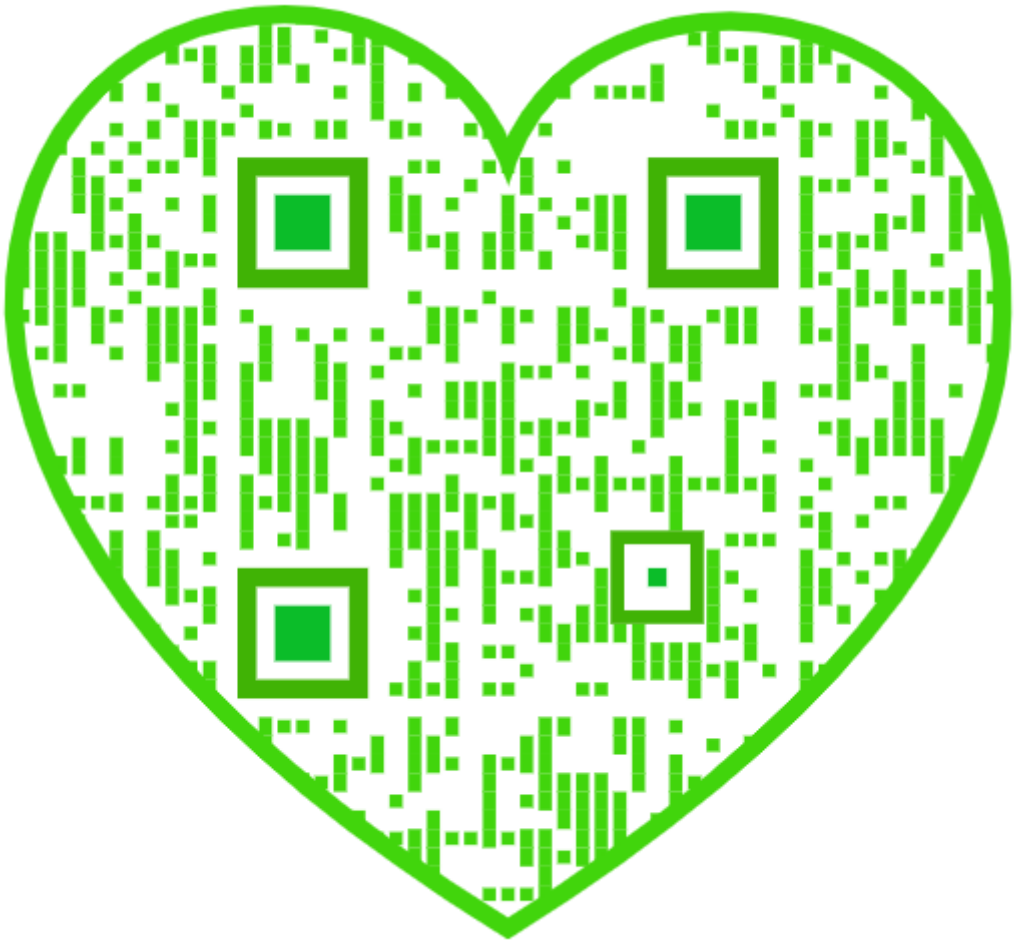
SD
373
.N3

FORESTRY FOR PROFIT



NEW JERSEY
DEPARTMENT OF CONSERVATION & DEVELOPMENT
STATE HOUSE, TRENTON



Class SD 373
Book .N3

STATE OF NEW JERSEY
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF FORESTRY AND PARKS

FORESTRY FOR PROFIT

By WILLIS M. BAKER
ASSOCIATE STATE FORESTER

TRENTON, NEW JERSEY
JULY 1, 1922

LIBRARY OF CONGRESS
RECEIVED
NOV 5 1923
DOCUMENTS DIVISION

CONTENTS

PAGE

THE NEED FOR FORESTRY 3

NEW JERSEY'S TIMBER RESOURCES:—Forest area; Forest regions; Cutover and burned forest; Merchantable timber; Rank of species; Timber consumption; Timber growth and future production; Forest values 3

THE PUBLIC'S INTERESTS DEMAND STATE AID:—An adequate timber supply is essential; State Foresters aid woodland owners; Expert advice; Cost; Necessity for action is recognized 6

WHAT IS FORESTRY?—Forestry is farming applied to woodlands; Forestry never appropriates agricultural soils; Forest planting is frequently advisable; Forestry demands and creates good markets; Fire protection is absolutely essential 9

WOODLAND MANAGEMENT 14

PRINCIPLES OF FORESTRY:—Forestry pays good profits; A definite plan of work; What are productive woods 14

Leave a Full Stand:—Competition for light; Root competition; How to determine a full stand; How to get a full stand 15

Favor Thrifty, Vigorous Trees:—Cut dead, dying and weakened trees; Cut crooked, misformed and injured trees; Cut mature and over-mature trees 16

Favor Best Species:—Consider the products desired; Resistance to enemies; Influence of site 17

Soils Adapted to Various Species:—Fertile, well-drained soils; Wet, swampy land; Dry, rocky upland; South Jersey sands 18

PRACTICAL APPLICATION OF FORESTRY:—Various types of woods require different treatment 19

Young, Even-aged Mixed Hardwoods:—Thinning; Examples of thinnings; Records of thinnings 19

Middle-aged Mixed Hardwoods:—Treatment needed; Results of improvement cutting; Reproduction cutting; Sprout and seedling reproduction; Control of sprouting; Control of seeding 23

Mature Mixed Hardwoods:—Maturity of growth; Merchantable maturity; Treatment of mature stands 26

Culled Hardwoods:—Improvement cutting in culled hardwoods 28

Fine Forests:—Pitch pine and shortleaf pine; Reproduction of pine; Pine sprouts; Pine a paying crop for South Jersey; Yields from pine .. 28

PAGE

Pine and Hardwoods:—How to favor the best species; Pure pine or mixed pine and oak 31

White Cedar Forests:—Cedar is capable of intensive management; Cedar must be thinned carefully 32

MARKETING FOREST PRODUCTS:— Investigate markets; Products for home use; Local sale of products; Shipping products; Sale of stumpage; Timber sale contracts; A home sawmill; Directory of dealers and industries 34

WOODS WORK:— 39

Season to Cut:—Fall and Winter; Work in the woods at odd times 39

How to Cut—Logging:— Trees marked for cutting; Felling trees; Low stumps; Thorough utilization; Hauling; Seasoning and storing products 40

Slash Disposal:— Logging slash is a menace; Lopping tops; Burning slash; New Jersey's Fire Law 43

FOREST PLANTING:— The need for planting 45

WHERE TO PLANT:—Abandoned fields; Burned woodlands; Woods denuded by careless lumbering; Under-planting; Special timber crops; Farm timber 45

WHAT TO PLANT:—Species adapted to conditions; Species suited for the products desired; Hardwoods or evergreens; Pure or mixed plantations; Quick growing trees; Nut trees; Species not recommended; Table of species recommended for planting 47

HOW TO PLANT:—Season to plant; Young trees more satisfactory than sowing seed; Size of trees; A home nursery; Use of wild stock; Where to get trees; How to handle trees before planting; Heeling in; Preparing the ground; Light requirements; Spacing; Trees per acre at various spacings; Care of seedlings while planting; Planting; Important directions to follow; Planting crews; Lining and spacing 51

SUBSEQUENT CARE:— Little attention needed; Replacements; Cutting back; Cleaning; Pruning limbs; Thinning 56

COST AND PROFITS OF PLANTING:—Cost of labor; Cost of trees; Cost of average plantations; Profits from plantations; Expected yields and profits 57

PAGE

HELPFUL INFORMATION. 61

CHARACTERISTICS AND USES OF FOREST TREES:— Hardwoods and evergreens 61

Hardwoods or Deciduous Species:— Oak, Hickory, Ash, Chestnut, Tulip poplar, Basswood, Aspen, Cottonwood, Elm, Beech, Maple, Birch, Gum, Locust, Walnut, Butternut, Cherry, Sycamore, Apple, Sassafras, Dogwood, Persimmon, Holly, Hornbeam, Blue beech, Witchhazel..... 61

Conifers or Evergreen Species:—Pine, Spruce, Fir, Cedar, Larch, Hemlock 66

MECHANICAL PROPERTIES OF WOOD:— Great variation in mechanical properties; Weight; Hardness, Stiffness; Strength; Resistance to shock; Durability 69
Table of mechanical properties of woods..... 72

WOOD PRODUCTS AND USES:—Lumber; Poles; Furnace poles; Piling; Ties; Fence posts; Mine timbers; Cordwood; Baskets; Boxes; Cooperage; Wood pulp and paper; Excelsior; Charcoal; Hardwood distillation; Naval stores; Tanning; Dyewoods; Wood preservation; Miscellaneous products 70

TIMBER ESTIMATING:— Sample plots; The strip method..... 77

Measuring Trees:—Diameter; Height; Recording measurements..... 78

Computing the Contents of Trees:—Volume tables; Sample volume tables of Red Oak in board feet of sawed lumber; Small, second growth hardwood cordwood in cubic feet; Shortleaf pine in board feet of lumber; Pine cordwood in cubic feet..... 79

UNITS OF MEASURE—CONVERTING FACTORS:—Board measure; Log measure; Comparison of Doyle and Scribner Log rules; Scribner Log rule; Cord measure; Cubic measure; Table of converting factors; Table of quantity of material contained in trees of various sizes..... 82

TREE PESTS:—Forest insects and tree diseases; Where to get information. 85

Do your woods show this sort of care? It pays!

Bigger, better and more profitable timber crops grow faster if you cut out the crowding, inferior trees and leave the thriftiest ones of the best species. You also get an immediate profit from the work.

FORESTRY FOR PROFIT

by WILLIS M. BAKER
Associate State Forester

THE NEED FOR FORESTRY

The purpose of this publication is to advise woodland owners *how* to make their timber tracts productive and profitable by the practical application of common sense management—forestry. Much has been said and written of the necessity for checking the devastation of our rapidly diminishing forest resources, and of the need for providing a future timber supply. The average person, and the average woodland owner, agrees that "such waste should not be allowed and people really ought to do something about it." Meanwhile he continues to neglect his own woodlands, apparently not realizing that he can help solve the Nation's timber problem, and at the same time greatly increase the value and income of his property by giving his woods a part of the same attention he would give his work, his farm, or his business. The average owner must realize that his woodlands are not a liability, but an asset; that it will pay him in dollars and cents to treat them right. This publication will inform him how to get results.

For those who do not realize the seriousness of the timber shortage that is already beginning to make itself felt, a few facts regarding New Jersey's forest resources and timber consumption will be enlightening. The following estimate is based on data collected in 1921.

NEW JERSEY'S TIMBER RESOURCES

Forest Area.— It is a well-known fact that our forests have been seriously depleted by wasteful lumbering, devastated by repeated forest fires, abused by the public and neglected by their owners. Practically all of the original or virgin forest has disappeared, but New Jersey still has two million acres of second-growth and cut-over woodland, which is 46 per cent of its total upland area. Probably one-quarter of this forest area consists of soils that could and some time may be used for agriculture. Yet for many years forest land cleared for farming and industrial development has been closely balanced by abandoned fields reverting to woodland. At least 1,500,000 acres must grow trees or remain forever unproductive.

Forest Regions.—New Jersey's forests are divided into two distinct regions. The hardwood region of 750,000 acres (three-eighths of the total forest area) lies north and west of a line from Seabright to Glassboro to Bridgeton, and includes North Jersey uplands as well as the heavier soils of the Raritan and Delaware valleys. The South Jersey pine region of 1,250,000 acres (five-eighths of the total forest area) lies south and east of this line, on the light, sandy soils of the coastal plain. (See map, page 5.)

The hardwood region contains mainly deciduous species: oak, chestnut, maple, hickory, beech, tulip poplar, ash, birch, gum, elm, etc., with small

quantities of the conifers (evergreens), white and pitch pine, red cedar and hemlock, and negligible quantities of black spruce, white cedar and tamarack.

The South Jersey pine region contains principally pitch and short-leaf pine and white cedar, with considerable oak on cut-over land. Many persons believe that South Jersey consists largely of "scrub oak" and "pine barrens," and can never grow good forests. This belief is fortunately incorrect. The native species naturally make good timber, and are scrubby in form only where severely burned or abused. In this region pine occupies nearly half the area; brush land (recently cut-over or severely burned) one-quarter; oak and hardwoods about one-quarter; cedar swamp about 4 per cent, or one twenty-fifth.

Cut-Over and Burned Forest.—Nearly 70 per cent (1,400,000 acres) of the total forest area has been recently cut-over or so severely burned that the present tree growth, while potentially valuable for future forests, is now too small or too scattering to be merchantable. Of this area, 400,000 acres, three-fourths of which is in the South Jersey pine region, does not contain trees large enough even for cordwood, while the remaining 1,000,000 acres would now yield approximately 7,000,000 cords of wood, both pine and hardwoods, suitable only for fuel.

Merchantable Timber.—Approximately 30 per cent of the forest area (600,000 acres) now contains merchantable timber estimated at 1,640,000,000 board feet of saw timber, poles, ties, piling, etc., and 5,000,000 cords of wood. Of this total stand, yellow pine (pitch and shortleaf) will yield 360,000,000 board feet, cedar 100,000,000 board feet, and all hardwoods (together with white pine and hemlock) about 1,180,000,000 board feet.

Rank of Species.—The various hardwood species rank in abundance about as follows: oak, 65 per cent; maple, 10 per cent; hickory, 5 per cent; beech, 4 per cent; tulip poplar, 3 per cent; ash, 3 per cent; birch, 2 per cent; gum, 2 per cent; elm, 2 per cent; other species, 4 per cent. In the same way, the conifers rank as follows: pine, 79 per cent; cedar (red and white), 20 per cent; hemlock, 1 per cent. Of the four native species of pine, pitch pine ranks about 80 per cent; shortleaf pine, 18 per cent; white pine, 1 per cent; scrub pine, 1 per cent. Ranking conifers and hardwoods together on the scale of 100, we get the following comparison of the relative quantities of each: oak, 47 per cent; pine, 22 per cent; maple, 7 per cent; cedar, 6 per cent; hickory, 4 per cent; beech, 3 per cent; tulip poplar, 2 per cent; ash, 2 per cent; birch, 1.5 per cent; gum, 1.5 per cent; elm, 1.5 per cent; hemlock, 5 per cent; other species, 2 per cent. Chestnut is not included because of its destruction by the blight.

Timber Consumption.—New Jersey consumes the equivalent of 600,000,000 board feet of timber annually, half of which is sawed lumber used in industries and for construction, while the other half is used in rough form for poles, ties, piling, mine timbers, posts, cordwood, etc. The annual output of New Jersey sawmills is approximately 30,000,000 board feet, or one-tenth of the sawed lumber consumed, leaving nine-tenths to be imported. On the other hand, about two-thirds of the round and rough timber used in the State is produced locally. Very little New Jersey timber is exported.

Map of New Jersey's 2,000,000 acres of woodland.

Practically all of this area will grow good forests, and most of it is fit for no other use. Neglectful owners and forest fires are keeping much of it idle and non-productive. New Jersey now has to import more than two-thirds of the timber used in the State, but there is enough true forest land here to grow all the timber needed by her citizens and industries.

Therefore, of the total annual consumption of timber, the equivalent of 230,000,000 board feet (38 per cent) is produced within the State and 370,000,000 board feet (62 per cent) is imported. At present freight rates it costs the people of New Jersey not less than $5,000,000 annually for freight alone on imported timber.

Timber Growth and Future Production.—New Jersey is now cutting the equivalent of 230,000,000 board feet annually from her 2,000,000 acres of forest land or 115 board feet per acre per year. An annual production of 300 board feet per acre per year, which is easily possible once the forests are protected from fire and are put to work under forestry management, will yield an amount equal to all the timber now used.

However, it must be remembered that not over 30 per cent of the woodland area (600,000 acres) now contains merchantable timber, and it is this area that is supplying the present annual cut. At this rate, the merchantable timber will last less than ten years. When this is gone, there will be a period of several years during which sizable timber will be very scarce, and probably nine-tenths of all kinds used will be imported. Yet if the areas of young growth recuperating from cutting and fires are given proper protection and care, they will come back, and, under methods of regulated cutting, will produce constantly increasing annual yields. New Jersey can eventually grow practically all of the timber needed for home consumption. Before this situation is reached a period of acute local shortage can be expected.

Forest Values.—New Jersey's present merchantable timber resources have a stumpage value of about $25,000,000—not including the value of the land,—although the present assessed valuation probably does not exceed one-quarter of this amount. In fixing this valuation, 70 per cent of the total area is regarded as having no actual stumpage value at present, although of course the young growth is the foundation of our future forests, and as such, has a decided value. The stumpage value of the cut now amounts to about $2,000,000 annually, and the market value of the sawed lumber, poles, ties, etc., about $10,000,000.

In 10 years the value of the cut will probably amount to not more than one-fourth of this amount. Ultimately, when the forests are made fully productive, they should have a capitalized value of more than $200,000,000; the stumpage value of the cut should exceed $10,000,000 annually and the total market value of the raw products should exceed $50,000,000. These expectation values are conservative, since they are based on present prices.

THE PUBLIC'S INTERESTS DEMAND STATE AID

An adequate timber supply is essential to the welfare of any community or State; the public's interests demand that steps be taken to assure it. The advantages resulting from a home grown supply of lumber and wood products will benefit everyone—Mr. Average Citizen and Mr. Ultimate Consumer as well as forest owners and timber operators. The return to productivity of our great area of idle, semi-waste lands will add immeasurably to the

public wealth. Nor should the recreational value of woodlands be overlooked. Desolate slashings, monotonous brush land and unsightly burned areas do not serve or attract people bent on pleasure, but once the mountain and lake regions of North Jersey and the pine tracts of the south are forested as they should be, our inland summer and winter playgrounds will rival in popularity our justly famous coast resorts.

To bring the State's woodlands to the condition from which these benefits may be derived is the function and purpose of the Division of Forestry of the State Department of Conservation and Development.

The State Foresters aid woodland owners, because most New Jersey forest holdings are too small to justify the employment of a forester, and because the practice of forestry on private lands must be encouraged for the benefit of the public. The Department offers the services of its foresters, so far as their time will permit, to all who ask for assistance.

Expert Advice.—Advice is given by mail upon the basis of a very intimate knowledge of conditions in the State. Whenever the conditions and the owner's intent justify it, a forester will study the situation on the ground and make recommendations. The advice offered covers cutting, logging, marketing, planting, protection and general management problems. There is no obligation to follow the advice given, although when it is acted upon the Department assumes the right to inspect the property from time to time, and to publish the results of the work for the benefit of the public.

The cost to anyone receiving this help is the forester's actual field expenses. His salary is paid by the State. Public institutions and organizations are aided without charge. Advice by mail is always free.

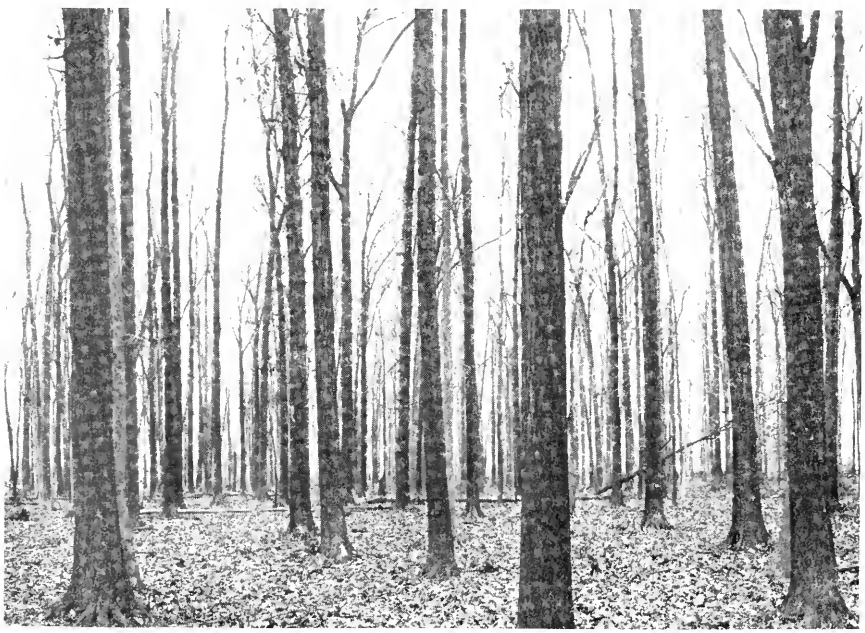
The Necessity for Action is Recognized.—To those who know the importance of our timber problem, it is gratifying to note that a constantly increasing number of progressive individuals and organizations not only see the need for "doing something," but are *doing it*. They realize that with the depletion of eastern stumpage, and with the increasing cost of transporting lumber from the South and West, wood product prices are mounting. This situation is just beginning to make itself felt. Wood-using industries are coming to recognize the importance and value of a permanent local timber supply for the future, and the benefits of having this supply near the largest markets, with the most accessible transportation facilities. No other State is so ideally located in this respect as New Jersey.

Sportsmen understand that there can be no wild life—no fish or game—unless an adequate forest cover is maintained for its protection. Forest fires are the worst enemies of wild birds and animals.

A large mining concern in North Jersey employs a forester to manage its tract of several thousand acres of forest land, from which, under regulated cutting, it is able to obtain a permanent supply of timber needed for its operations, with a surplus for profitable sale. Owners of so-called "waste land" see the folly of allowing the land to remain idle and unproductive when it might be growing timber profitably. An estate of 100,000 acres of South Jersey woodland, consisting largely of recently cut-over and severely burned forest, has employed a forester to protect the property from fire, and

Cedar swamps like this are worth money

Who says South Jersey can't grow good pine?



A crop of 20,000 board feet of good hardwood sawlogs per acre.

New Jersey was once forested like this, and can be again. Our people now pay annually over $5,000,000 for freight alone on imported lumber. Properly developed, our forests can produce $50,000,000 worth of wood products a year—all we need.

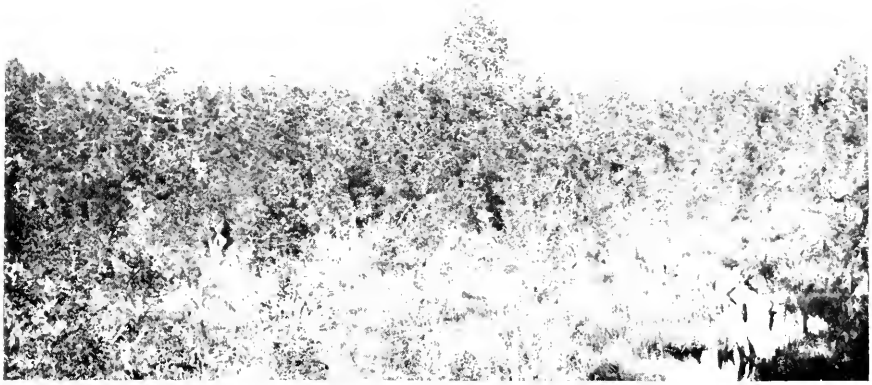
to encourage the growth of profitable timber crops by carefully controlled cutting. Municipal water departments controlling watersheds of many thousand acres in North Jersey are conserving the available water supply and making a profit as well by protecting the natural forests on their watersheds, and by planting unprotected slopes with forest trees. Six of the thirteen forest fire lookout towers now operated by the State have been furnished in part by woodland owners who offer this cooperation because they know the necessity of protecting forests from fire. Farmers realize the benefits of producing their own supply of lumber, poles, posts and fuel, as well as profitable woods work for idle help and teams during the slack season. In addition to the 17,000 acres of State Forests maintained by the State, several hundred owners of nearly 200,000 acres of New Jersey woodland have started the practice of forestry on their properties. They are locking the barn doors to prevent their horses being stolen. They will ride while others walk, when the timber shortage really hits us.

WHAT IS FORESTRY?

Forestry is Farming Applied to Woodlands.—Every forest should be regarded as a growing crop, to be protected, encouraged, cultivated and finally harvested according to the best and most profitable methods. Under proper management an area of woodland will produce a continuous crop, maturing at intervals and yielding the maximum quantity and quality of products. It needs much the same treatment as a field of vegetables, which, after being thinned, weeded and otherwise encouraged to grow thriftily, are picked as they ripen. When trees are too crowded, the stunted individuals should be removed and the best left. Weed trees of inferior species interfere with the growth of the better trees, and should be cut out. The result of this thinning and weeding process, which in itself yields profitable returns, is a full stand of healthy, valuable trees. As certain individuals reach the size at which they can be most profitably utilized they should be cut and marketed, and the immature trees left to grow.

Forestry management is especially adapted to farm woodlands and can be practised with profit by any capable farmer. It employs labor and teams in winter when other work is often slack; it requires few special tools and little extra equipment; it provides necessary farm lumber, posts and fuel at a minimum cost; it brings in ready cash from the sale of surplus products; it utilizes land unfit for any other purpose; it stabilizes the whole management of a farm.

Forestry never appropriates agricultural soils, but makes profitable use of poor land. It is economically unwise to use lands of high value for growing timber when we have approximately one and a half million acres—steep hillsides, rocky slopes, non-fertile soils and swamps—that cannot be used profitably for any other purpose. However, present woodland should be maintained as such until it is needed for other uses. With at least 400,000 acres of neglected or abandoned farm lands within the State, it is obvious that the present need is for more farmers and better marketing conditions rather than more farms. Possibly 500,000 acres of New Jersey woodland consist of soils suitable for agriculture if cleared.



Logged off cedar swamps will come back in cedar unless burned.

Fire will keep pine timber scrubby.

Careless logging is wasteful, dangerous and unsightly.

Nearly 70 per cent of New Jersey's woodlands look like this—run-down and non-productive from fire, neglect and abuse. To allow them to continue in this condition is not good business.

Forest planting is frequently advisable, although the common idea that forestry begins and ends with planting trees is wrong. It is usually easier, cheaper, and for the present, better, to make good forests out of neglected and abused natural woodlands. The result will rarely be as good, silviculturally, as from a planted forest, but the crop will come quicker and it will cost less. In our woodlands natural reproduction is usually adequate and satisfactory, and costs nothing to establish. Forest planting is advised where land unfit for agriculture has been unwisely cleared, where the native forest has been completely burned, or where natural reproduction is lacking. *The State grows no young trees* for distribution to the public, because there are a number of private nurserymen who furnish good stock at fair prices. The State Forester will send any interested person a list of available nurseries where planting stock or supplies can be obtained.

Forestry Demands and Creates Good Markets.—Forestry is practical only when, and to the extent that, forest products are marketable at a profit. Forestry methods encourage the growth of the largest and most valuable crop; when it matures it must be thoroughly utilized and profitably marketed if the operation is to be successful.

The old law of supply and demand is the factor governing the practicability of forestry. In the past when good timber was abundant and cheap, a forest owner could not afford to use the same intensive methods that are practical now. It was cheaper to waste timber than to waste money to save it. As a result, we have our slaughtered, neglected forests.

Today the increasing value of wood products is directly proportional to the diminishing supply of timber and it seems certain that prices will continue to increase. The demand for wood is constant; neither concrete nor steel can replace it for many uses. New Jersey has an abundance of cheap land for timber production; a consuming population of more than ten million within a radius of 60 miles of the Capitol; excellent markets within the State and at its borders; unexcelled steam, electric, water and improved highway transportation facilities. Considering these facts, and that at present more than two-thirds of the timber used in New Jersey is imported, and in 10 years probably nine-tenths or more must come from outside the State, the possibilities for forestry seem unlimited.

Fire Protection is Absolutely Essential.—Only where forests are reasonably safe from fire damage is the growth of timber possible and the practice of forestry advisable. Fortunately, the danger of fire in more or less isolated woodlots, especially in the hardwood region, is not so great but that owners can be reasonably assured of protection once they realize the damage even a light burning may cause by destroying soil humus and fertility, by killing young reproduction and damaging large trees.

However, extensive areas of New Jersey forests still continue to suffer from frequent and destructive fires, especially in South Jersey, where particularly hazardous fire conditions exist. There are still too many fires, too destructive fires, too great an annual fire loss. Forest fires must be stopped—confronted with a timber shortage, nobody longer questions that fact. The State Forest Fire Service must be strengthened along the lines proposed in the

Fire is the chief cause of poor forests.

Prompt detection from towers, and efficient fire fighting are necessary for fire control.

Railroad fire lines and clean roadsides reduce the chance of fires starting, and help in stopping fires set by careless smokers, campers and brush-burners.

Forest fires burn over 70,000 acres of forest annually in New Jersey. The State Forest Fire Service can reduce this damage to a small amount if it gets proper support. How much longer will the public and woodland owners stand for this criminal waste and neglect?

State Firewarden's report for 1921. The increased cost of this addition will be negligible compared with the value of the timber and other property that will then be saved from destruction.

With a public that realizes the danger and damage of forest fires, so that their number can be checked, and an organization that promptly detects and controls the fires that do start, forestry becomes practicable and its progress assured.

WOODLAND MANAGEMENT

PRINCIPLES OF FORESTRY

Forestry Pays Good Profits—Few woodland owners can afford to play with forestry as a hobby. When considering the management of woodlands, the first question asked by most persons is, "What will it cost me, and what can I get out of it?"

The answer is this: Forestry is by no means a get-rich-quick proposition, but the returns are sure and steady. Neither does forestry involve waiting a life time for results, as so many persons believe. Thrifty woods properly managed pay good profits and utilize land that would otherwise be unproductive; regulated cutting produces income at frequent intervals of a few years apart. Little capital and only small initial investments are required.

Today the average New Jersey woodland tract is so run-down that it cannot be expected to yield the most profitable timber crops until its condition is improved. One or more *improvement cuttings* are usually necessary to prepare for full productivity.

Ordinarily the cost of such improvement work is more than paid for by the sale of the wood removed. How large these first profits are depends upon the condition of the woods, and how the work is undertaken. An improvement cutting in a typical 90 acre Morris County woodlot yielded a net profit of $45 per acre, and only dead, dying, crowding and inferior trees were cut. As a result, those remaining are now growing vigorously and are rapidly increasing in value. Still more profitable cuttings will be possible from time to time at intervals of a few years, as these trees mature.

A similar improvement cutting of a 20 acre tract in Burlington County yielded a net profit of $300 and left a far more valuable woodland because of the treatment.

A Middlesex County farmer, following the advice of the State Forester, writes as follows: "It is a pleasure to tell you that I have nearly finished cutting and marketing the timber on my thirty acre tract. . . . It is conservative to say that I will net about $35 per acre above all expenses on the chestnut alone (dead, dying and inferior trees), and I will have a good tract of young oak and other hardwoods left, worth at the present time $15 per acre stumpage. The best offer I could get from lumbermen was $25 per acre for all the timber, and this would have meant leaving stump land to detract from the value of my farm."

Other similar examples might be given. In every case the full benefit of the work will not be apparent until the final crops of timber are harvested. Any woodland owner who gives his woods the right sort of attention will find good profits for his efforts. It is assumed that an owner recognizes this fact, and is prepared to follow the plan of management that will bring about this improvement. If he is governed by any other special considerations he must choose the next best course to follow.

A definite plan of work should be based upon the desires or needs of the owner. He should determine in advance exactly what he wants to do, and

should know to what extent his desires can be fulfilled. Ordinarily he is governed chiefly by one of the following considerations:

(a) The desire to improve the productiveness of his woods so that the largest and most valuable crops of timber can be grown in the shortest time.

(b) The need for certain products for immediate sale or use.

(c) The necessity for cutting everything of value to realize the greatest immediate profit.

Success in obtaining either of these last two results, without sacrificing too much the welfare and future productivity of the stand, depends upon the initial condition of the woods and the skill with which the work is undertaken. The owner's final plan of action must in many cases be a compromise of what he would like to do and what seems most advisable.

What Are Productive Woodlands?—What is the condition toward which a forest owner should work? Woodlands are 100 per cent productive when all the land is constantly supporting a *full stand* of the most thrifty, well-formed, fastest growing trees of the most valuable species adapted to conditions of soil and climate.

Select the Trees to Leave.—Ordinarily the best way to go about an improvement cutting is first to decide upon the best trees to be saved for further growth and then mark the rest for cutting. This procedure should be followed wherever the owner's chief intent is to improve his woods. If some specific products are required it is of course necessary to cut the trees that will provide them, leaving the best of the remaining trees.

No one should attempt to carry out the following instructions unless he is thoroughly familiar with the characteristics of the trees in his woods. Helpful information of this kind is given on pages 61 to 77.

Be guided by the following considerations in selecting trees to cut and to leave:

LEAVE A FULL STAND

Leave a full stand of trees so that the land will be fully occupied, and will be growing the largest crop possible. What comprises a "full stand" of trees depends upon the species and their light requirements, their age and size, and soil conditions.

Competition for Light.—The leaves of trees require sunlight to perform their life functions, one of the most important of which is to make plant food available for the tree's growth. Even in rich soil a tree which is getting insufficient light will be stunted or even killed.

Certain species which tolerate considerable shade, such as white cedar, hemlock, spruce, beech and maple, can stand more crowding without injury than can such intolerant species as pine, tulip poplar and white oak. Also any species growing under favorable conditions is more tolerant of shade than when growing among unsuitable surroundings. Most species are more tolerant of shade in youth than later on in life.

A tree's crown (limbs and foliage) develops according to the light it receives. Overhead shade is what kills off and prunes the lower limbs of a

tree. A tree grown in the open develops a short, stocky trunk and a spreading crown with an abundance of large limbs and is of little value for lumber. On the other hand, a tree in crowded woods is forced, by competition with its companions, to grow tall as rapidly as possible in an effort to get from above the light needed for its development. Such a tree grows tall, straight and free from lower branches,—the kind most desirable for lumber or other products.

Therefore, young trees should grow closely until they have developed good height and form. During this struggle some individuals will be stunted and suppressed. To increase the rapidity of diameter growth of the best trees, when they have reached the desired height and form, crowding should be relieved by removing the weaklings and less desirable trees. In other words, a full stand means crowded young trees, but a more open stand as the trees mature.

Root competition for food and moisture also influences the growth of crowded trees, but for all practical purposes it is safe to follow the general rule that when a tree is getting all the light it needs, there will be no competitor close enough to afford serious root competition.

How to Determine a Full Stand.—To determine whether or not a tract of timber is too crowded, too open, or of just the right density, consider the species, the age of the trees and the condition of the crowns. Remember that tolerant species can stand the most crowding and that young trees should always be more or less crowded until they have reached their desired form.

In an over-crowded woods the crowns interlace making a dense, overhead shade; the crowns are small and the trees themselves are rather spindly, with many of them suppressed and even dead. If the stand is too open there will be considerable sunlight on the ground, and the trees will have large spreading crowns with the live limbs extending well down the trunks. The trees themselves will usually be short and stocky.

How to Get a Full Stand.—When a tract of timber has reached the size and age where it is too crowded for good development, the best young trees should be retained for further growth and the crowding trees cut. What these best trees are is explained in the following paragraphs. If the stand is too open, before or after cutting, it is necessary to provide for more trees in the openings, by natural seeding when possible, by sprout reproduction from stumps of trees cut, or by planting.

FAVOR THRIFTY, VIGOROUS TREES

Leave Thrifty, Vigorous Trees.—When selecting trees for further growth, leave only those that are thrifty and full of vigor. The idea of forestry is to get a succession of the largest and best crops in the quickest time; to accomplish this the trees must be healthy, of good form, fast-growing and free from disease or injury.

Cut dead, dying or weakened trees, and utilize them if they are merchantable, for if left in the woods they constitute a fire menace, a breeding

place for destructive insects and fungus diseases, and soon become worthless. Healthy woods usually do not suffer from attacks of pests.

Cut crooked, misformed and injured trees, to make room for better trees that can grow into more valuable products. In productive woods there is no room for inferior individuals. Badly suppressed trees, which have been overtopped, crowded and weakened by larger and more vigorous neighbors usually grow very slowly and readily succumb to disease or insect attacks, although some species may recover and make satisfactory growth if the crowding is relieved in time.

Cut Mature and Over-mature Trees.—They have no place in productive woods, because when a tree has reached the age of maturity it no longer produces wood vigorously. Unless market conditions make it appear likely that the future value of such trees will be considerably greater within a few years, they should be cut at once. Over-mature trees deteriorate rapidly the longer they are allowed to stand. Moreover, these larger trees, particularly those with spreading crowns, use too much space and crowd out younger trees that might otherwise be making good growth. One hundred dollars at 10 per cent interest yields more income than two hundred dollars at 3 per cent; the same comparison applies to the growth of trees.

BEST SPECIES

Favor the Most Valuable Species.—The trees left standing to form productive woods should not only be thrifty and properly spaced, but they should also consist of the best species. Ordinarily the best species are those which yield the most valuable products. Oak, hickory, ash and tulip poplar are more valuable than birch, beech and maple, which in turn are more valuable than sassafras, ironwood and aspen, for most purposes. However, a thrifty, well-formed beech or birch is better to favor than a weakened, injured oak or hickory.

Consider the products desired in order to determine the relative value of the various species. For instance, if a farmer wants only cordwood, birch, beech and hard maple are as good as oak or hickory and better than tulip poplar or elm. For veneer basket logs, red gum and tulip poplar are better than oak, hickory or ash, and so on.

Fortunately most kinds of wood will soon be in such demand that the owner who needs no particular products, but desires to grow those that can be most readily sold at a profit, need only consider what species are best suited to his soils. Whatever kinds he can grow best will certainly be marketable.

Resistance to Enemies.—The best species to favor are those that can best resist enemies, or other unfavorable conditions likely to be encountered. Thus chestnut is a valuable species, yet it has been necessary to eliminate it entirely from consideration because of the blight which destroys it. There are few more valuable trees than white pine, but it is commonly injured by the weevil, and there is also constant danger of the blister rust disease. Therefore red pine, not as susceptible to injury from these or other pests, is recommended for

planting as a substitute for white pine. Elms are well adapted to wet sites and produce valuable wood for many purposes, but shallow-rooted trees like elm are likely to be wind-thrown if the stand is opened too much. No species resists light burnings as well as pitch pine, so that it is well fitted to survive in regions where fires are frequent. For detailed information regarding the characteristics, habits and uses of trees, see pages 61 to 68.

The influence of site also determines what are the best species to favor. The best trees must not only be those most valuable for the purpose or products desired, but they must also be well adapted to conditions of soil, moisture, exposure and climate. For example, tulip poplar is a better tree for many purposes than rock oak or pitch pine. It grows faster, makes better formed and larger trees, and its wood has a higher market value. But tulip poplar demands a fairly fertile, moist but well-drained soil. On a dry, rocky slope, or on sands of low fertility, pitch pine is the better tree to favor, for it will make fair growth where tulip poplar would be barely able to survive. For the same reason rock oak should be favored on dry, rocky slopes, and pin oak on excessively moist sites. Loblolly pine seems to be an excellent species well adapted to the South Jersey sands (when planted) but it is not at all suited to the climate of North Jersey. Red gum is found naturally only in Central and South Jersey, and hard maple only in North Jersey; neither species should be favored except within its natural range.

SOILS ADAPTED TO VARIOUS SPECIES

Fertile, Well Drained Soils.—Almost every tree species prefers a deep, fertile, moist but well drained soil for its fastest growth and best development, although hardwoods usually demand better soils than conifers. Certain species require good soils, and grow poorly or not at all on inferior sites. Black walnut is probably the most exacting of our native trees, followed by tulip poplar, white ash, shagbark hickory, basswood, sugar maple and white oak, all valuable species. Fortunately much of our hardwood region contains good soils, either too steep, too rocky or too wet for agriculture, where these species can be favored.

Wet, Swampy Land.—Southern white cedar, found in the fresh water swamps of the South Jersey Pine region, is a good example of a tree thriving on soils constantly wet and often overflowed for most of the year. In the swamps of the hardwood region are found elm, black ash, black gum and red maple with the comparatively rare conifers, tamarack and black spruce. Hemlock, swamp white oak, white ash, basswood, pin oak, beech, birch and sugar maple also endure considerable moisture if it is not stagnant. Red gum is common on wet lands in the southern half of the hardwood region. Cottonwood and balsam fir are adapted to planting on wet soils.

Dry, Rocky Uplands.—Few species make good growth on the more or less dry, rocky uplands and ridges of North Jersey, although those best adapted to such situations are chestnut oak, pitch pine, red cedar and gray birch. Scotch pine is a suitable species for planting on such situations.

South Jersey Sands.—The species best adapted to the poorest South Jersey

sands is pitch pine, while shortleaf pine makes good growth on the better situations. The various oaks, especially chestnut oak, red oak, black oak and white oak do fairly well on the best soils, although the sands are not naturally hardwood soils. Any of our pines seem adapted to planting in this region, although the best species to use are probably shortleaf, loblolly and Scotch pine.

PRACTICAL APPLICATION OF FORESTRY

Various Types of Woods Require Different Treatment.— As woodlands vary according to species, age and condition, so they require different methods of management to make and keep them productive. The following advice for various types of New Jersey woodland will help an owner to understand the treatment needed by his woods.

YOUNG, EVEN-AGED MIXED HARDWOODS

Young hardwood forests, under 40 years of age, comprise one of the most common classes of woodland in the State. Such stands of young "second growth" are found where all the original timber was cut clear in one operation, where land cleared for agriculture and then abandoned has reverted to forest growth, or where a severe fire entirely killed the former forest. Nature has restocked these areas from seed already on the ground or distributed from nearby seed trees, or by sprouts from the stumps of the original trees. Usually the woods are a mixture of sprouts and seedlings of many species, some valuable and some of inferior quality.

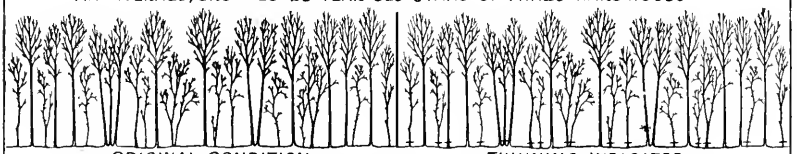
Such stands are commonly very dense and crowded, a desirable condition until the trees have been forced to good height and form. When about 20 years old, and usually before the age of 30 is reached, crowding begins to do more harm than good by seriously checking diameter growth (of the trunks) of even the leaders or *dominant* trees. If nothing is done to relieve this situation, the larger trees will gradually win out over the others, and will ultimately produce a fair stand of timber. But this process of Nature is very slow, for wood growth is seriously retarded in the struggle for supremacy; also it is very wasteful, for many trees are *suppressed* and die.

Thinning.—It is usually advisable to *thin* young stands, when badly crowded, at about 20 to 25 years of age. Less crowded woods can be allowed to remain unthinned longer—possibly until 40 years old. The trees to be removed are the crowded and suppressed trees of the less valuable species, leaving the dominant trees of the better species for further growth. The products of this cutting will be chiefly cordwood, fence posts, small poles, mine timbers, ties, boat fenders, etc. Ordinarily the profits of such a thinning will not be great, but will usually more than pay for the cost of the work. The real benefit, proven by experience, is that the trees relieved by thinning produce wood from five to ten times as fast as crowded trees unthinned.

Examples of thinning will demonstrate the value of this work:

(a) A 20 year old stand of various species of oak on the sandy soils of

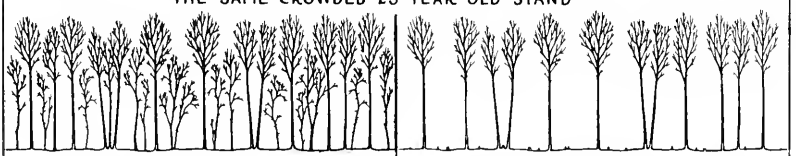
AN AVERAGE, CROWDED 25 YEAR OLD STAND OF MIXED HARDWOODS



ORIGINAL CONDITION — THINNING INDICATED

The average 25 year old crowded stand contains about 750 trees per acre, 30 to 40 feet tall, 2 to 8 inches in diameter, averaging 4 inches in diameter, with a total volume of about 15 cords of wood

THE SAME CROWDED 25 YEAR OLD STAND



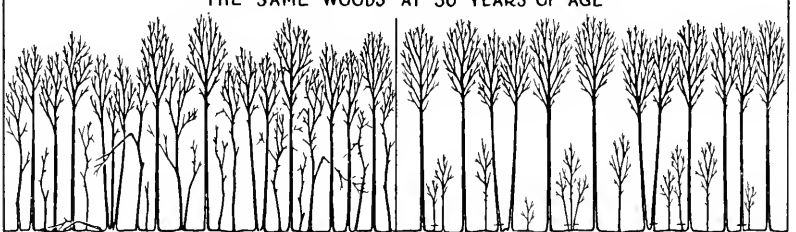
UNTHINNED

750 trees per acre, 30 to 40 feet tall; maximum diameter, 8"; average 4", Volume, 15 cords per acre.

THINNED

450 trees per acre, 30 to 40 feet tall; maximum diameter, 8"; average 5" Volume left, 10 to 12 cords per acre.

THE SAME WOODS AT 50 YEARS OF AGE



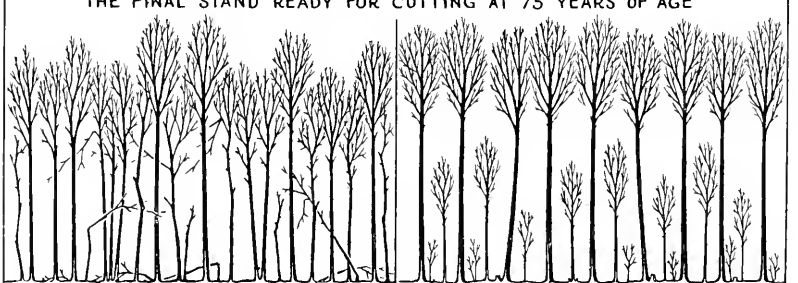
IF NEGLECTED

150 trees killed by crowding, 600 trees per acre living, 40 to 60 feet tall; the maximum diameter, 14"; average 5" Volume 18 to 20 cords per acre

IF IMPROVED

450 trees per acre, 50 to 60 feet tall, maximum diameter, 18", average, 10" Volume 35 to 45 cords per acre. THE 2ND IMPROVEMENT CUTTING *indicated here would leave 200 to 300 trees per acre with a volume of 30 to 35 cords.*

THE FINAL STAND READY FOR CUTTING AT 75 YEARS OF AGE



IF NEGLECTED

500 trees per acre living, 50 to 75 feet tall; maximum diameter, 18", average, 8". Volume 25 to 35 cords per acre, or 10 thousand board feet of saw-logs and 15 cords of wood.

IF IMPROVED

250 trees per acre, 60 to 75 feet tall, maximum diameter, 24", average, 15" Volume 60 to 75 cords or 30 thousand board feet of saw-logs and 8 cords of wood. Also repraduction for another stand

Diagrams showing the results of thinnings and improvement cuttings in hardwoods.

Burlington County, containing 731 trees per acre from 2 to 5 inches in diameter, was thinned. A similar tract of crowded timber adjoining was left in its natural condition as a check. From the first acre 268 suppressed trees were removed, leaving 463 trees. In seven years the trees left on the thinned acre increased in volume from 5.5 cords to 12.3 cords, or practically 1 cord per acre per year. The unthinned acre increased in the same time from 9.5 cords to 10.6 cords, or a growth of only 1.1 cords in 7 years. In other words, the thinning resulted in increased growth nearly 10 times as great as that on the unthinned plot.

The practical application of this example is as follows: In many parts of the State, particularly in South Jersey, it is a common practise to cut off entire stands of young hardwoods about every 15 or 20 years for cordwood. This practise is unwise and wasteful, because such short rotations do not give the trees time enough to make good growth. A tree thoroughly established, which has passed the spindly youthful stage but is not yet mature, with its thrifty crown of foliage, its healthy well formed trunk, its well established, spreading root system, will add to its volume each year many times as much wood as several young trees occupying the same space and struggling to establish themselves.

For example, take an average stand of South Jersey oaks. After cutting, reproduction by sprouts will follow. In 15 years there will be from 4 to 5 cords of wood per acre, in 20 years from 6 to 10 cords. Two clear cuttings, the first at 20 years and the second at 40 years, would yield a total of 16 cords of wood in 40 years. In 45 years three clear cuttings 15 years apart would yield altogether about 15 cords.

Under proper forestry methods the stand would be thinned instead of clear-cut, at 20 years. The thinning would remove about 2 or 3 cords per acre, and would leave from 5 to 8 cords standing for further growth. At 40 years of age this stand would contain from 25 to 30 cords of wood, or double the amount which would have been obtained from the two or three clear cuttings. Moreover many of the trees would be of a size and quality suitable for products more valuable than cordwood. A longer period of growth would make a contrast of yield and profits even more striking. At any time the improved woods would have a sale value much greater than that of the slashings, resulting from clear cutting of immature growth.

(b) In the western part of Essex County an acre of 25-year old hardwoods—oak, maple, hickory, beech and ash, contained 870 trees from 2 to 8 inches in diameter, with a volume of 17.8 cords. Investigations showed that growth had been fairly rapid for the first 20 years, but had been badly retarded by excessive crowding in the last five years. Adjoining was an acre of crowded trees 50 years old, grown under conditions similar in every respect. Here there were 620 trees per acre from 2 to 10 inches in diameter with a total volume of 20.4 cords. Study of growth rings on the stumps showed that these trees had been badly crowded and had made little growth during the last 30 years. Many of the suppressed trees had been killed by crowding, which accounts for the fact that the 50 year old woods contained 240 live trees per acre less than the 25 year old tract. The important point to note is that under similar conditions one acre produced 17.8 cords of

RECORD OF THINNINGS AND IMPROVEMENT CUTTINGS ON FIVE ONE-ACRE TRACTS OF MIXED HARDWOODS

Tract No.	Age of Stand in years.	Number of Trees Per Acre.			Range of Diameter of Trees in Inches.			Average Diameter of Trees Above 2 In.			Volume of Wood in Cords.		
		Before Thinning.	Cut.	Left.	Before Thinning	Cut.	Left.	Before Thinning.	Cut.	Left.	Before Thinning.	Cut.	Left.
1	20	731	268	463	2-5	2-4	2-5	2.8	2.3	3.2	6.7	1.2	5.5
2	(a) 25	872	380	492	2-8	2-4	2-8	3.7	2.8	4.4	19.5	3.5	16.0
3	(b) 30	745	372	373	2-10	2-7	2-10	3.6	3.3	3.9	17.1	7.7	9.4
4	50	620	304	316	2-10	2-8	2-10	4.2	2.9	5.4	20.7	3.7	17.0
5	60	512	260	252	2-12	2-10	2-12	5.1	3.7	6.5	28.7	6.2	22.5

(a) The soil of this tract was quite fertile, although too rocky for farming, and therefore supported an unusually dense growth.

(b) This tract was thinned heavily, as the owner wanted the trees left to grow to maturity without the need of later improvement cuttings.

wood in 25 years, while the other produced only 20.4 cords in 50 years. Had the 50 year old stand been thinned at 25 years of age, it would undoubtedly have produced at least 40 cords in 50 years, or double its actual yield. These figures are given in terms of cords for the sake of comparison. Many of the trees would have been fit for sawlogs, poles, piling, ties and similar products.

(c) On page 22 the records of actual thinnings and improvement cuttings made in different parts of the State give a good idea of the number of trees in average crowded stands of hardwoods, the number of trees properly removed, and the volume of wood standing and cut.

MIDDLE-AGED MIXED HARDWOODS

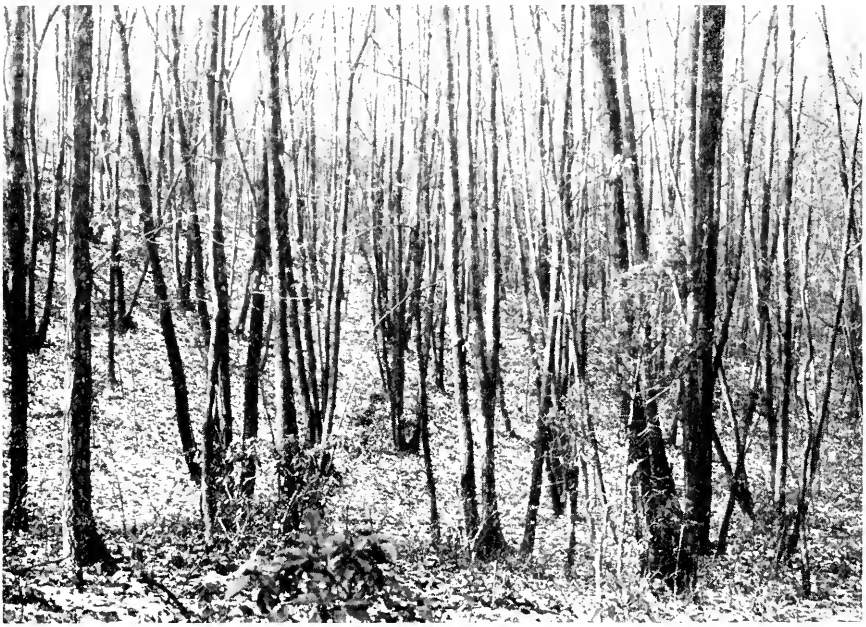
After a thinning like that described for crowded young hardwoods, the trees should grow vigorously and at an increased rate of growth for some time. Later, usually after 10 to 25 years, the stand will again become crowded enough to retard growth. Most of the trees will be of fairly uniform size, since they were largely dominant trees when relieved of crowding by the initial thinning. There will be some injured trees, others suffering from crowding, and usually some trees of inferior species which had to be left at the time of the first thinning.

Middle-aged mixed hardwood stands are also found as the result of natural growth that has never been thinned. In this case the trees are less uniform in size, they are more crowded, many of them are dead, dying, weakened or suppressed, and the average size of the trees is considerably smaller than in the case of a stand previously thinned. There is less wood per acre and its quality is poorer.

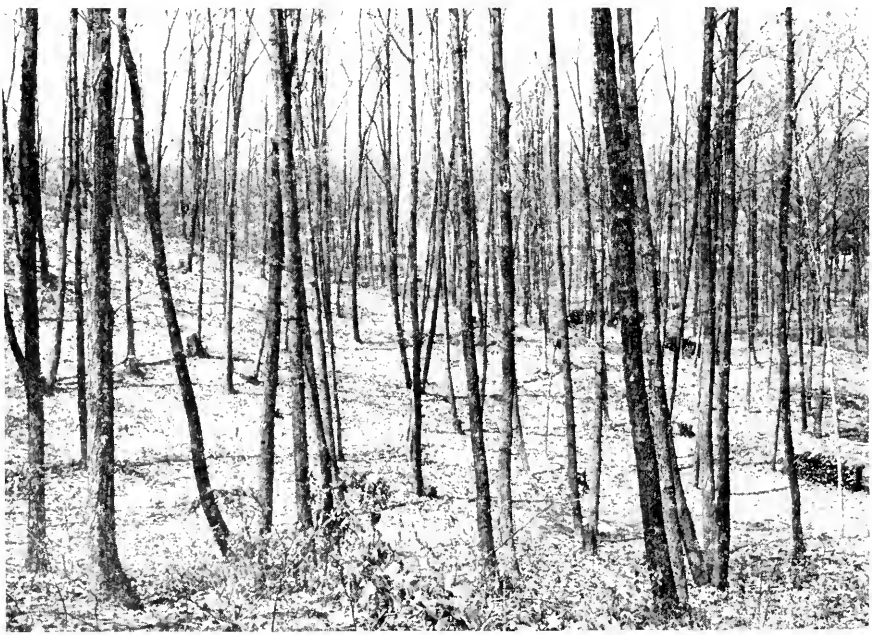
If an owner can afford to hold a part of such timber still longer it will ordinarily pay him to do so. At this size and age it is still growing thriftily, and is rapidly becoming better in quality. Other things being equal, one large tree or log is worth more than three smaller ones of the same total volume. Furthermore, we are now just beginning to feel the pinch of the timber shortage, and the next five or ten years will undoubtedly see a very considerable increase in the stumpage value of timber as well as in the value of manufactured lumber and wood products. Fortunate indeed is the person who owns and can hold a tract of thrifty timber approaching maturity.

Treatment Needed.—If it is possible to retain a portion of such timber for further growth, an improvement cutting should be made similar in method to that described for a young stand. Crowding should be relieved by removing the inferior and less thrifty individuals of the poorer species, retaining only the best trees of the most desirable species. Such a stand can be opened up more than in a thinning of younger timber because the trees will have more nearly reached their final height and form. Increased diameter growth is now wanted and each tree should have more light than was needed earlier in life.

Results of Improvement Cutting.—At the time such an improvement cutting is made, there will ordinarily be from 300 to 600 trees per acre, ranging in diameter up to 16 inches and with a total volume of from 25 to 50



A typical stand of young hardwoods too crowded for further good growth.



The same woods after an improvement cutting which removed the crowding and inferior trees and left the best to grow.

Such a cutting yields a profit over and above the cost of the work, but the chief benefit is the larger, better, more valuable and faster-growing crop of timber that will follow.

cords per acre. The measure of cords is used again for the sake of comparison, although cordwood will be only a portion of the products removed. There will be small saw logs, trees fit for piling, poles, ties, mine timbers, dimension stock, cooperage stock, basket logs, fence posts, etc. Limbs, tops and small and inferior trees can be turned into cordwood.

This cutting should yield a considerable profit. For instance, a woodland owner in Morris County made a net profit of $3,842 in cutting over 90 acres in this manner, and left a stand of timber that is rapidly increasing in size, quantity, quality and value. His profits from the next cutting should be considerably greater. On one of the State Forests in Burlington County a similar cutting in a 40-year old stand of 20 acres yielded a net profit of $300, removed only the equivalent of 13 cords per acre, and left 15 cords per acre which have been increasing for the last 10 years at the rate of 1 cord or 500 board feet, per acre per year. Moreover, this cutting was made at a time when timber prices were comparativly low. The next cutting, which can be made when the stand is 60 years of age, should yield 35 cords or 18,000 board feet per acre, worth at least $300 per acre stumpage at present prices, but with the prospective increase in timber values, it will probably be worth much more 10 years from now.

Moreover, it should be pointed out in this connection that the owner who cuts and markets his own timber will get an additional profit from the operation, usually equal at least to that realized from a sale of stumpage. In other words, if an acre of timber is worth $200 as it stands, the same trees can usually be sold for more than twice this amount if cut into logs and delivered to a mill or manufacturing plant. The actual cost of the work accounts for only a part of the difference in price. Since most timber owners can handle this work themselves it is entirely fair to include these marketing profits when considering the income from forestry. A farmer doesn't estimate his profits on a crop still in the ground,—he figures what it is worth harvested and ready for sale.

Reproduction Cutting.—Frequently an improvement cutting in middle-aged hardwoods will be in the nature of a *reproduction cutting;* that is, its purpose will be not only to increase the growth of the trees retained, but also to start young trees which will perpetuate the stand when the time finally comes to cut the matured timber. As trees are removed openings are made where new seedlings can become established, and sprouts will start from the stumps of the trees cut. If the stand was previously thinned while young, there may already be a few scattered seedlings and sprouts established, the best of which should now be saved. In this way a new crop of young trees will be started while the final crop is still maturing.

Sprout and Seedling Reproduction.—Seedlings grow from seeds scattered by the parent tree, while sprouts grow from buds formed on the stumps or roots of trees. Most hardwoods sprout, some species more readily than others. Successive generations of sprouts from the same stump usually become less thrifty. Mature trees sprout less vigorously than young trees. It is common to find sprouts growing from the base of a dying tree—Nature's last effort to enable the tree to perpetuate itself.

Young sprouts grow more rapidly for a time than seedlings, for the sprouts have the old roots of the parent tree to draw upon for food and moisture. Sooner or later the old stump dies and decays, and if the sprout has no root system of its own, it also suffers. Observations have shown that sprouts usually grow to a size merchantable for ties or poles (12-16 inches in diameter) faster than seedlings and then slow up, deteriorate, or even die. Seedlings usually start more slowly, but gradually overtake and pass the sprouts in middle age, and eventually make larger mature trees.

A stump usually sends up a number of sprouts—from two or three to a dozen or more. If left to nature a few of these will crowd out the others, and become dominant; the rest will die off. There comes a time when these several sprouts are such a drain on the old root system that they all slow up in growth. Before this time is reached, all but one or two of the best sprouts from each stump should be cut. This work forms an important part of improvement cuttings.

Control of Sprouting.—The most productive hardwood stands are formed from both sprouts and seedlings, for this combination will insure the largest production of wood during early life. When the thinning is made, the percentage of sprout trees in the stand can be reduced in favor of the best seedlings. In the next cutting, if the sprouts have reached their best development, they can be eliminated entirely. If quick rotations of small sized trees are desired, sprouts can be favored.

Sprouting can be encouraged or not as desired by the time and method of cutting. Low, clean stumps mean better sprouts, for they will start close to the ground and soon establish themselves. They will then be less affected when the parent stump decays than would be the case if they started higher up.

If trees are cut during the dormant period of growth—late fall, winter or early spring—sprouts will start with the spring growth and will have a whole season to become hardened against the rigors of the coming winter. If cutting is done in middle or late summer the sprouting will not be so vigorous, and many sprouts will not be mature enough to withstand winter weather and will die. By the following spring the stump will be able to sprout only feebly, if at all. It is sometimes feasible to discourage sprouts by cutting them off as they appear. Usually only two or three cuttings are necessary, since the stump soon loses its vitality with this treatment.

Control of Seeding.—It is also possible to encourage seedling growth by opening up the stand with a cutting just before a seed crop. Most trees ripen their seed in the fall;—exceptions are elm, red birch, red maple, cottonwood, aspen and willow, which ripen seed early in the summer. Good seed crops usually do not occur every year but periodically. Most species produce mature seed in one year; some, such as the black oaks and pines, require two years to ripen seed. Stirring up the ground and exposing mineral soil by logging usually aids the seeds that fall to become established.

MATURE MIXED HARDWOODS

After one or more thinnings or improvement cuttings, the final mature stand will result. There are also found scattered throughout the State,

mostly in farmers' woodlots, mature stands as the result of the gradual domination of the most vigorous trees in tracts of woods that have received no particular care. In these natural stands the number of large trees, their average size, the quantity and value of the timber will all be less than in the case of tracts that have reached maturity after a succession of improvement cuttings. See diagram, page 20.

Maturity of Growth.—A tree is mature in growth when it has reached its best development in size and quality. The age or size at which a tree matures depends upon the species, the site and other conditions of growth. Needless to say, it is advisable to cut mature trees and start others growing as soon as possible for growth practically stops with maturity. Growth of average hardwoods in the region of New Jersey begins to slow up when the trees are from 18 to 24 inches in diameter and from 75 to 125 years old. In a virgin forest, where trees of all sizes occur up to and including mature trees, wood production is practically at a standstill, for death and decay balance new growth.

Merchantable Maturity is the size at which the tree can and should be marketed for a certain product. An oak tree 14 inches in diameter would be merchantably mature for railroad ties, while one 16 to 20 inches in diameter would be merchantably mature for piling. Whether or not a tree of tie-size should be marketed for ties, or held until piling or saw-log size, depends upon the needs of the owner, market conditions and the condition of the tree. In the present and coming period of rising timber values, it is felt that an owner will make no mistake by holding timber that is growing thriftily.

Treatment of Mature Stands.—If the mature stand of large trees is sufficiently open so that seedling reproduction has already come in, the best plan is to cut all merchantable timber. When freed from the overhead shade of the larger trees, the established seedlings supplemented by sprouts from stumps of the trees cut, will form another stand, which in 20 to 30 years will be dense and crowded and will then be ready for the preliminary thinning, described on page 19. So the crops grow in a continuous rotation. The land is never idle; a crop is always growing at maximum speed.

If there is no reproduction on the ground when the time comes for cutting the mature crop, new trees must be established in some way. Ordinarily, if the stand is opened up by the removal of two-thirds or three-quarters of the mature trees, those remaining will seed up the area within a few years, after which they can be removed. Seed trees left should be of the species desired for the coming crop and should have fairly large crowns so as to produce seeds abundantly. When a stand of large trees is opened up there is always danger of windthrow, especially among shallow rooted species. Trees on wet sites are most liable to this damage for their roots are near the surface.

After harvesting the mature crop, it is sometimes necessary to establish new growth by forest planting, where suitable reproduction is not already on the ground, where a change in species is desired, or where it seems advisable not to delay for natural reproduction. Where some reproduction is present but not enough to establish a full stand, it can be supplemented by planting. (See chapter on forest planting, pages 45 to 60).

CULLED HARDWOODS

A large portion of New Jersey's hardwood forests have been partly cut-over again and again; each time the best trees have been removed, until today there remains what is known as a *culled forest.*

This culling operation started years ago, in the mature virgin forest. In those days lumber was cheap and abundant, so that it was profitable to cut only the most valuable trees. Later on, as timber became scarcer and prices rose, it became profitable to cut trees that had been previously left. On most areas within the last 10 to 20 years another heavy cutting has been made, and not only have trees of saw-log size been taken, but also those fit for poles, piling and ties. Each successive cutting has removed the best trees and left the poorest. The present stand contains those that were crooked, deformed or partly decayed. There are many dead and dying trees still standing. Each cutting has opened up the stand enough for some new growth to start from seeds or sprouts, so that with the scattering, inferior old trees are mixed young trees of all ages, from seedlings and saplings to pole size. This is a typical stand of culled hardwoods.

Improvement Cuttings in Culled Hardwoods.— Obviously such a forest needs an improvement cutting, if it is to be made productive. Old mature, large-crowned trees should come out, to make room for thrifty ones. Many of these large trees will be fit only for cordwood; others can be used in part for short sawlogs, split posts, ties, etc. All dead, dying, deformed and unhealthy trees should be cut. In spots there will be thick stands of crowded young growth that should be thinned. Always keep in mind that the trees to be left should form as nearly as possible a full stand of vigorous trees of the best species adapted to the conditions. Frequently there will be a number of trees from 6 to 12 inches in diameter, which were not quite ready at the last cutting for poles, piling, ties or sawlogs, as well as an understory of smaller trees. Enough of the best trees of all sizes should be kept to fully occupy the ground. Later, when a sufficient number of the larger trees have become merchantable, they should be harvested, and those immature left to grow. It is just like picking ripe vegetables and leaving the green to ripen. This process can be kept up rotation after rotation, crop after crop, until by the constant selection of the best trees, the woodland is made fully productive. Usually after a cutting or two a fairly even-aged stand will have been secured, after which management should be along the lines previously recommended for young, middle aged and mature hardwoods.

PINE FORESTS

Pine requires treatment somewhat different from that of hardwoods, because it does not produce good trees from sprouts, does not tolerate as dense, crowded stands, and requires more light and space for successful seedling reproduction. These characteristics must always be kept in mind; otherwise the same principles governing the handling of hardwoods apply to the management of the pine forests which extend over large areas of the South Jersey sands, or of planted pine forests. Keep a full stand of healthy, thrifty trees growing vigorously, and cut when mature in such a way that the stand will

Growth of young pine checked by crowding.

The same woods after a cutting which liberated the thriftier trees and profitably salvaged those that were weakened and dying.

While some of the characteristics and habits of growth of pine differ from those of hard woods, the same principles of proper treatment apply.

perpetuate itself. Where crowding is observed, growth of the best, dominant trees should be encouraged by thinning out the inferior, weakened and suppressed trees. As a rule, fairly open stands of pine do not need much attention, except fire protection, until the crop matures.

Probably the most profitable management of pine forests is to thin crowded stands at from 25 to 30 years of age and clear-cut all the remaining trees at from 40 to 60 years. The thinning will yield cordwood, charcoal wood, dunnage wood, pulpwood and possibly box boards, while the final cutting will yield logs fit for box boards and lumber.

Pitch pine and shortleaf (two-needle) pine are the two commonest species in South Jersey. The latter usually grows straighter and its wood is of better quality for lumber, but pitch pine is better adapted to the poorer soils. Where both species are found together, shortleaf pine should be favored.

Reproduction of Pine.—Demanding abundant sunlight, pine seedlings will not start well under shade. Therefore, if there is not already sufficient reproduction on the ground when a mature stand of pine is cut, seed-trees should be left to restock the area. There are two ways to do this. A portion of the mature trees—say one-quarter of the total stand, widely spaced with ample openings between—can be left until the openings have been reseeded and then removed by a second cutting. Sometimes it is possible to leave a scattering stand of trees not yet fully mature, to re-seed the area. If this does not seem advisable, a few (5 to 10) seed trees per acre can be left permanently to guarantee re-seeding. Pine seeds, borne beneath the scales of the cones, are winged so that they are scattered by the wind several hundred feet from the parent tree. Distribution is usually best in the direction toward which the prevailing winds blow. Where seed trees are to be left permanently they must be wind firm, with sufficient crown to produce abundant seed, and of the least value for lumber so that their loss from the previous cutting will be least felt. It is sometimes feasible to salvage them after seeding has been accomplished, although if left permanently they guarantee reproduction if a forest fire should kill the young trees already established. If this happens, and no seed trees are left, planting must be resorted to.

Pine Sprouts.—Unlike most conifers, the pines of South Jersey sprout like hardwoods, but the sprouts never make sizable, thrifty trees. They do become mature enough to produce seed, and this feature may aid in the reforesting of large areas of land in South Jersey where fires have killed all seedling growth and all seed trees of pine. Possibly seed from the sprouts of the fire-killed pine will eventually restock these areas, although it is a question still being studied, whether seed from pine sprouts will produce good pine timber. Perhaps, if the answer is found to be negative, it will partly explain the reason for so much "scrubby" pine in South Jersey.

Pine is a Paying Crop for South Jersey.—It is a common, although incorrect belief, that the South Jersey sands cannot produce good timber and that the pine is always scrubby. Where scrubby timber exists, it is the result of repeated forest fires, which injure or kill growing trees, and which rob the soil of fertility by destroying the humus or decayed leaf litter. Stop fires and South Jersey will grow good pine timber.

There is, and probably always will be, a constant demand for box boards by the fruit, berry and vegetable growers, as well as by the manufacturing industries of the State. Pine is well suited for this product and since comparatively small sized logs can be used, the crops can be harvested at an early age. Such short rotations mean quick profits and the greatest possible production.

Yields from Pine.—An excellent stand of 60 year old shortleaf pine observed in Ocean County contained 480 trees per acre from 6 to 14 inches in diameter, which would yield about 18 thousand board feet of sawlogs. As the tract had never been thinned, the trees were rather crowded and spindly, with long clear trunks. If the tract had been thinned at about 25 or 30 years of age, there would have been left standing from 250 to 300 trees per acre, which at 60 years would have been from 8 to 20 inches in diameter, with a total yield of at least 25 thousand board feet.

In Burlington County a tract of cleared land was abandoned 35 years ago, and seeded up naturally to pine from the surrounding woods. As a result there is now an excellent stand of shortleaf and pitch pine, with 450 trees per acre ranging in diameter from 4 to 12 inches, with a total volume of 13 thousand board feet, or 26 cords per acre. Growth was very rapid for the first 25 years, but has been much retarded by crowding for the last 10 years. To relieve this, 175 trees per acre yielding 6 cords of wood were cut, and 275 trees (20 cords per acre) were left standing. As a result, the stimulated growth should yield at least 20 thousand feet of sawlogs per acre when the stand is cut at 50 years of age. Without the thinning the yield would not have been over 15 thousand board feet at 50 years.

These tracts of pine are better than the average, for they have been protected from fire. An average, rather open 50 year old pine stand measured in Burlington County contained 150 trees per acre from 6 to 15 inches in diameter, with a volume of 6 thousand board feet. This tract was not fully stocked and growth had been retarded by forest fires, which were not severe enough to kill the trees. The contrast between this tract and those first described affords a most convincing argument for forestry.

PINE AND HARDWOODS

Where pine and hardwoods are found together, the species most desired or best suited to growing conditions should be favored. Pine ordinarily makes better growth than hardwoods on poor, dry soils and should be favored on such sites. For this reason pitch pine commonly dominates hardwoods on the dry rocky ridges of North Jersey and on the poorer of the South Jersey sands.

How to Favor the Best Species.—When a stand of hardwoods and pine is cut the hardwoods immediately sprout, form a cover of dense shade, and prevent the reproduction of pine. This is the reason why oak seems to replace pine when cut and why pine is slow to come back on cutover areas, where it was formerly more abundant. Where there are pine seed trees left they will sooner or later seed in the openings, so that gradually the proportion of pine will increase. Where this condition exists and pine is desired, these

seedlings and seed trees should be favored, and any cutting of hardwoods should be made just before a good pine seed crop. The sprouting of hardwoods should be discouraged as much as possible by mid-summer cutting and by the cutting back of subsequent young sprouts. If a stand of hardwoods should be desired, pine can be eliminated easily by cutting the seed trees.

Pure Pine or Mixed Pine and Oak.—Although it is known that pine is one of the best, if not the best, species to grow on the South Jersey sands and that it will succeed well in pure stands, it is possible that a proper mixture of pine and oak will utilize the better soils of this region to the best advantage. The State foresters are now studying this type to determine whether or not this is so. The advantages of this mixture seem to be as follows: at the time the first thinnings are made, if there is oak to cut, it will yield better cordwood and more of it than pure pine; but pine, on such soils, is best adapted for growth to sawlog size, and should be part of the stand so that it may be left for the final crop. Decayed oak leaves will enrich the soil more than pine needles. In short, considering the entire rotation of thinnings, improvement cuttings and the final crop, it is felt that pine and oak may yield more wood and greater profits than could be obtained from pine or oak alone. Where this mixture is not obtained naturally it can often be made by planting pine seedlings between oak stumps on land recently cutover. This mixture has the advantage of being cheaper to plant than pure pine since at least half of the area will be restocked by oak sprouts.

WHITE CEDAR FORESTS

In the past very little study has been made of the proper management of white cedar, which forms pure stands in the fresh water swamps of South Jersey, because, after the timber has been cut off, most cedar swamps have been converted into cranberry bogs. Where conditions are not suited for this development, white cedar can be grown very profitably. This species should not be confused with the common red cedar, or juniper, which is scattered throughout the State, commonly on dry, rather sterile soils.

Cedar is capable of intensive management, because any tree 2 inches or over in diameter is marketable at a profit. The wood is durable in the ground, so that small trees are sought for bean poles, oyster stakes and rustic work; larger trees make good grape stakes, fence posts, telephone and electric poles. Logs 3 to 4 inches in diameter are sawed into lath, while larger logs make shingles, box boards, siding, etc. Utilization is very complete.

White cedar is very tolerant of shade and forms dense, pure, even-aged stands, usually so crowded that growth is very slow. Like other species it responds to thinning by increased rate of growth. While cedar does not ordinarily make very large trees, it is so tolerant and its crowns are so small that an astonishing number of trees can grow on a given area. And since even the smallest trees can be used, a large quantity of products can be cut from even a small tract.

Thinning Cedar.—When a stand of cedar reaches the age at which many of the trees are from 6 to 10 inches in diameter (usually at about 35 to 40 years under good conditions), there will be hundreds of trees per acre that are crowded, suppressed, dead and dying. Clearly the commonsense practice

White Cedar is so tolerant of shade and forms such crowded stands, that growth is naturally slow.

But when freed from excessive crowding, cedar responds with a greatly increased rate of growth.

White Cedar is especially adapted to intensive treatment because all sizes of material, even small poles, are readily sold at a profit.

is to salvage these before they become worthless. They can be cut and sold at a profit and their removal will benefit the remaining trees. Even stands of cedar of bean pole size can be profitably thinned, and should be unless the owner is not interested in profits.

For example, in a 35 year old tract of crowded cedar in Atlantic County, there were 2,656 trees per acre from 2 to 8 inches in diameter. A thinning removed 1,064 of the most stunted and crowded trees, while 1,592 of the thriftiest were allowed to grow. This cutting yielded 400 rustic furniture poles and 1,240 bean poles per acre, which were sold at a good profit. These trees were retarding the growth of the thriftier trees and most of them would have died within a few years. Enough were left to form a full mature stand and the ultimate crop will be larger, of better quality and will mature more quickly because of this improvement cutting. (See illustration, page 33.)

The advantage of thinning early is clearly demonstrated by an unusually crowded 65 year old stand of cedar on one of the State Forests in Burlington County. One acre contained 7,296 trees, the largest of which were only 4 inches in diameter. An experimental thinning, to determine whether trees of this age would respond to liberation after long suppression, removed 3,185 trees per acre, and left 4,111 to grow. Enough of the trees cut were fit for bean poles to enable the work to pay for itself. A comparison of this tract with the 35 year old stand previously described shows emphatically the harmful results of continued crowding.

Cedar Must Be Thinned Carefully.— Just how heavily cedar can be thinned is not definitely known, although the State foresters are now studying this problem. In their constantly wet environment a cedar's roots do not need to grow deep for water—hence it is easily uprooted by wind or bent over by heavy snow and sleet. The natural close stands are cedar's protection. In thinning care must be taken not to open up the stand too much so that it will be liable to such damage.

It is believed that the tendency of cedar to windthrow and snow damage can be prevented to some extent by starting to thin early while the trees are yet in the "bean pole stage," so that they gradually become accustomed to a more open stand. To determine this fact, experimental cuttings are now being made and studied on the State Forests. The first cutting is made in stands of bean pole size, when the products of thinning are first marketable. Subsequent thinnings are made as needed throughout the life of the stand.

MARKETING FOREST PRODUCTS

Investigate markets, after deciding what timber should be cut, but before starting the actual work of cutting. It is obviously a waste of time, money and timber to cut trees that cannot be disposed of profitably or used at home. Market conditions frequently make it advisable to leave trees standing which, for the welfare of the forest, should otherwise be cut. Again the owner must sometimes compromise what he would like to do with what seems most advisable under the circumstances.

Products for Home Use.—Farm woodlots yield many products for home consumption. The removal and use of cordwood not only improves the woods by utilizing dead, diseased or inferior material which hinders the growth of better trees and which would otherwise be wasted, but also cuts down fuel bills considerably. (See page 71.) Fence posts are constantly needed on the farm and even non-durable, inferior species can be used if the owner provides an inexpensive home creosoting plant, described on page 76. If either chestnut or cedar are available, rail fences are frequently cheaper to construct and last longer than wire fences. Timbers and lumber for new buildings or repairs can usually be obtained from the woodlot more cheaply than the same material could be purchased elsewhere. A farmer who is handy with tools can frequently replace broken parts of wagons or farm machinery, axe and tool handles, etc., with timber from his woods.

Local Sale of Products.—Forest products should be marketed locally where possible, because transportation is costly and reduces profit. There is usually a good demand for cordwood and fence posts among local farmers who own no woodland, or among the residents of nearby communities. There are dealers in coal, ice and building supplies in most towns who also handle these products. Good local markets are provided by nearby wood-using industries, such as basket factories, box factories, stave mills, turning mills, furniture factories and similar industries. Railroad, trolley, telephone and electric companies frequently have local representatives who purchase ties or poles. Sawmill operators and lumber dealers ordinarily handle logs and most kinds of wood products, and often buy standing timber or "stumpage," as it is called.

Shipping Products.—Where products cannot be disposed of most profitably in local markets, it is advisable to ship direct to consuming industries or to dealers who handle them. This is especially true of high grade or special material such as walnut, oak, cherry and similar woods suitable for furniture or cabinet work; basket logs; ship knees and boat fenders; ironwood and dogwood bolts; furnace or puddling poles; hickory, oak and ash for tool handles, vehicles and implement parts; mine timbers and similar products. It is rarely practical to ship less than carload lots by rail, although automobile trucks frequently provide economical short distance transportation for smaller lots.

Sale of Stumpage.—A woodland owner is likely to find it most profitable to cut the woods and market the products himself, rather than to sell the trees as they stand in the woods. He will also then be assured of a careful job of cutting, just as he wants it done. If he is not able to handle this work himself, he can usually sell standing timber to sawmill operators, dealers or jobbers. When this seems necessary or advisable he should assure himself that his woods will be treated as he desires and not butchered.

Stumpage may be bought by the thousand board feet where sawlogs are wanted; by the cord for fuel or dunnage wood; by the tree or piece where poles, piling or ties are to be cut; by the acre, or by the entire tract purchased for a lump sum,—all depending upon the individuals and local custom. It is usually fairest to sell products subject to measurement after cutting at a

Pine woods left in good condition after cutting. Note the low stumps and absence of brush or slash to create a fire menance.

Careful cutting and thorough utilization in hardwoods. Every tree cut was worked up to the best advantage for poles, posts and cord-wood.

Raising good timber is only half the game; cutting it properly and disposing of it profitably is the other half.

specified amount per piece or per unit of measure (board foot, cord, linear foot, etc). Stumpage prices vary as to species, products and localities, since they are based upon the sale value of the product, less the cost of logging, manufacturing, marketing, and the operator's profit. A stand of timber close to market would bring a higher stumpage price than one several miles away, because it would cost the operator less to handle it.

Timber Sale Contracts.— Woodland owners should draw up a written contract covering every sale of timber stumpage. Even in small sales much trouble and financial loss may result from failure to put the terms of the sale in writing.

The primary aim of the seller should be to make absolutely clear the conditions under which he desires to dispose of his products. The essential provisions to be inserted in the complete form of timber-sale contract refer to the description and location of timber to be cut; the price and manner of payments; conditions of cutting and removal; title and means of settling disputes.

As an aid to those unfamiliar with such contracts, a sample agreement is given, showing the more important provisions that should ordinarily be included in the average sale, where the owner wishes to protect himself and his timber against undue damage. No single form of contract will suit all classes of sales, but owners of woodland should have no difficulty in adapting this contract to their use.

SAMPLE TIMBER SALE AGREEMENT

THIS AGREEMENT entered into this.....(*25th day of October, 1922*) between.....(*John Jones of Jonesville, New Jersey*), hereinafter called the Owner, party of the first part, and.....(*Henry Brown of Brownville, New Jersey*), hereinafter called the Purchaser, party of the second part;

WITNESSETH:

Article I. The Owner agrees to sell to the Purchaser upon the terms and conditions hereafter stated..... (*State definitely just what timber is to be sold. For instance:—all dead and down timber and all standing live timber marked for cutting within the Owner's 20 acre woodlot on his farm in Blank Township, 2 miles east of Jonesville.*)

Article II. The Purchaser agrees to pay to the Owner for his timber..... (*State definitely the terms of payment. This may be a lump sum for all the timber, with a specified time for certain payments, or the timber may be paid for at a certain rate per piece or unit of measure for the products cut, payments to be made at definite intervals, before the timber is removed.*)

Articl III. The Purchaser further agrees to cut and remove said timber in strict accordance with the following conditions:

1. Unless extension of time is granted, all timber shall be cut, paid for and removed before.....(*December 31, 1923.*)

2. All timber to be cut shall be marked or otherwise indicated for cutting by the Owner, and only timber so marked or indicated shall be cut by the Purchaser, except as follows: (*It may not be necessary to mark the trees by blazes under certain conditions, as, for instance, when all the timber is to be cut, or where only dead timber, trees of certain species, or trees above a certain diameter limit are contracted for.*)

3. Every tree marked or otherwise indicated for cutting shall be felled, worked up to the best advantage and fully utilized by the Purchaser. If any tree containing merchantable timber is felled and not used or removed, it shall be paid for at the

same rate as if it were used. (*This encourages close utilization and discourages waste.*)

4. Unless otherwise herein provided, sawtimber shall be scaled by the (*Scribner*) log rule, and measured at the small end of the log along the average diameter inside the bark. The maximum scaling length of logs shall be 16 feet; greater lengths shall be scaled as two or more logs. Upon all logs an additional length of 4 inches shall be allowed for trimming. Logs overrunning this allowance shall be scaled not to exceed the next foot in length. (*The Scribner log rule is probably the most satisfactory rule in common use in this region. Scaling extra long logs as two or more logs gives a larger and fairer scale than scaling one very long log.*)

5. Stumps shall be cut clean and as low as possible, in no case more than six inches above any physical obstruction. (*Physical obstruction means swollen or decayed butts, rocks, forks, etc.*)

6. No unnecessary damage shall be done to young growth or to any standing live trees.

7. The tops and limbs of all felled trees shall be closely lopped and the resulting brush..... (*State definitely how the brush is to be disposed of, as, for instance, scattered close to the ground, or piled in small piles and burned where it will not damage standing trees or young growth.*)

8. The Purchaser shall make and maintain in good condition such roads as are necessary for the removal of the timber and shall have the right to cut and use for such purpose any nearby pole wood, PROVIDED, HOWEVER, that the Owner shall first approve of the cutting of such wood and that no new roads shall be opened until their location shall have been approved by the Owner.

9. Any and all timber cut in violation of any of the provisions of this agreement and timber damaged by fire or otherwise, through the negligence of the Purchaser, his agents, servants, employees, contractors or sub-contractors, shall be paid for by the Purchaser; if six inches or more in diameter breast high, at double its market value, and if less than six inches in diameter breast high, at its market value plus (*$.25*) per tree or sprout, which amount shall be paid by the Purchaser and received by the Owner as liquidated damages.

Article IV. It is mutually understood and agreed by and between the parties hereto as follows:

1. All timber included in this agreement shall remain the property of the Owner until paid for in full.

2. The Purchaser shall do everything in his power, both independently and upon the request of the Owner, to prevent the origin or the spread of forest fire on the property covered by this agreement and shall use his entire force without charge to the Owner to extinguish any fire found on the same.

3. In case of dispute over the terms of this agreement, final decision shall rest with an arbitration board of three persons, one to be selected by each party to this contract, and the third member to be chosen by the first two selected.

4. This agreement is non-assignable, and a bond for the sum of (*$100.00*) shall be given by the Purchaser to the Owner, conditioned for the faithful performance of this contract. (*The Owner must decide whether or not a bond is necessary or desirable.*)

IN WITNESS WHEREOF the parties hereto have hereunto set their hands and seals this..... (*25th day of October, 1922.*)

Witnesses, HENRY SMITH. JOHN JONES, *Owner.*
SAMUEL WHITE. HENRY BROWN, *Purchaser.*

A home sawmill is rarely advisable for the average woodland owner, because most forest products can be marketed profitably in the rough, and because there are many small mills in most sections of the State now accessible to the person who occasionally wants a small quantity of lumber sawed. Many such mills do custom sawing; that is, logs are brought to the mill by the owner and the sawing is paid for in cash, or with a portion of the

lumber. To saw high grade lumber requires a first-class sawmill and an operator of considerable experience; many portable mills turn out only low grade products because of inferior equipment or because of the inexperience or carelessness of the sawyer.

Occasionally a woodland owner can operate a small mill profitably if he has sufficient timber and experienced help. He may even add to his profits by purchasing stumpage or logs from nearby woods or by custom sawing for his neighbors. However, there are many snares and pitfalls to be avoided in the sawmill business and anybody who contemplates entering the field should be fully informed of all its phases.

Directory of Dealers and Industries.—To enable woodland owners to find the best markets for their products, a file of New Jersey sawmill operators, timber dealers and wood-using industries is maintained by the State Forester. He takes no part in any sale and is not responsible for results, since the only purpose of this service is to bring together producers and consumers of New Jersey forest products. Information by mail is sent without charge upon request.

WOODS WORK

Know the Trees and Their Uses.—When the owner has become thoroughly familiar with the characteristics, habits of growth and uses of his trees (see pages 61 to 77), has studied market conditions, and has decided just what should and can be done with his woods, he is ready to go to work. As far as possible he should know just where he can sell his logs or other products and the sizes that are wanted. Otherwise an owner might cut his logs 12 and 16 feet long only to learn afterwards that the buyer wants 10 and 18 foot logs. Many sawmill operators prefer to buy the entire tree length so that they can be cut into the log lengths needed to fill specific orders. High grade logs might be fit for furniture or cabinet work, yet market conditions and transportation costs *may* make it more profitable to dispose of them for other uses.

SEASON TO CUT

Fall and winter are ordinarily the best seasons for woods work. Most woodland owners, especially farmers, can find slack time for woods work in the winter, when they would otherwise have idle help and teams on their hands. There is often more and cheaper labor to be had at this season. Frequently the only time that swamps can be worked is when the ground is frozen solid. In regions where snow is abundant, winter is a favorite time for logging on account of the ease and economy of hauling with sleds. Incidentally, when a man has to work fast to keep warm, he will accomplish more than on a hot, summer day.

During the dormant winter period of tree growth the "sap is down;" that is, there is supposed to be less moisture in the wood than during spring and early summer. Trees cut at this time are preferred for many products since they season more gradually and therefore do not warp or check as much as in hot weather. Most users of such products as poles and ties usually specify that they shall be cut during the fall or winter.

Work in the woods at odd times, if no regular season can be devoted to it. A few days at a time—or even a few hours' work—can accomplish wonders, if the worker keeps plugging away at every opportunity. When cutting stove wood or getting out a few fence posts, make the woods better for their removal. Although the most satisfactory job is ordinarily the one that is undertaken systematically, it isn't essential that the entire tract be worked over all at once. But no matter when or how the work is done, it should always be undertaken in accordance with a previously arranged plan, with definite objects in view.

HOW TO CUT—LOGGING

Trees Marked for Cutting.— To avoid confusion, trees to be felled should be lightly but plainly blazed with an axe, or marked with paint or crayon, and for convenience the blazes should all face in the same direction. When the owner wishes to be certain that only marked trees will be cut, he should stamp each blaze with his initials or some other identification mark raised like a die on the head of a specially prepared marking axe or hatchet. When such precaution must be taken, every tree to be cut should be blazed near the ground, on what will be the stump, as well as on the trunk about four or five feet from the ground. It will then be a simple matter to detect unmarked trees cut or marked trees uncut.

It is easier to detect crowding in hardwoods if the marking is done when the leaves are on.

Felling Trees.—It is generally easiest and quickest to cut small trees, up to 8 inches in diameter, with an axe. Larger trees are first notched with an axe on the side in the direction they are desired to fall, and then cut through from the opposite side with a cross-cut saw. The saw is less wasteful than the axe and is usually preferred in large timber because it cuts faster and easier. The person in charge of the work can decide, after a little experience, the proper tools to use.

Before a tree is cut the workers should decide in which direction it should be felled, so that it will not lodge against trees left standing. Care should be taken to fell it where it will do the least injury to young saplings and reproduction. Fell the trees so that the limbs and tops will be least in the way when the trunks are cut and skidded out.

In a stand of young timber the work is simple. Mature trees with large crowns complicate matters. Where a large tree is to be felled, it is easier to decide where it can best fall with least injury if the smaller trees to be taken out are first cut. Then an opening will appear as the logical place to fell the big tree. When this is done, however, if the tree happens to fall on the young trees left, there is no chance of leaving a second-best tree, since these have already been cut. But such difficulties are not of major importance and can usually be avoided with a little care and foresight.

Low Stumps.— It is obvious that low stumps mean more products, little waste and interfere least with hauling. Low stumps are sometimes impossible where trees are forked, or where they grow on steep hillsides, or among large rocks;—and impractical when the butts are swollen, hollow or decayed. A

Careless and wasteful logging. Brush and slash invite forest fires—merchantable timber cut and left to decay—standing trees damaged—no provision for another crop.

A butchered woodlot. Note the wastefully high stumps and lack of brush disposal. No thrifty young trees left to form a new stand.

With the rapid increase in value of forest products it is no longer profitable to slash through the woods like this. But some persons still do it, either from ignorance or force of habit.

good rule to follow is to cut within six inches of the ground where possible, or within six inches above any such physical obstruction. This rule is easier to follow in small timber than in large.

When sprout reproduction is desired, stumps should be cut low and with a saw if possible, for low stumps mean better sprouts. Smooth topped stumps resist decay longer, for there are no hollows to hold moisture.

Thorough Utilization.—After trees are felled they should be worked into the best possible products. What these best products are depends upon their value as well as the demand of the market. It can be easily determined what products will bring the greatest net profit.

For example, it is unwise to cut into cordwood trees that are fit for ties, poles, piling or sawlogs, if these products can be readily sold or used. Limbs, tops and inferior trees should go for cordwood. Get everything possible out of every tree. It is a well-known fact that under the old thoughtless manner of logging as much timber has been wasted as has been used. All the trees left in the woods should be growing, not rotting.

If 20 feet of a tree's length is fit for sawlogs, cut it into two 10-foot logs, or a 12-foot and an 8-foot log. Don't blunder ahead and cut a 16-foot log and then discover that 4 feet has been wasted because the next log is too short to be used. If there is a crook in the trunk, cut the logs so as to eliminate it if possible, rather than to have it occur in the middle of the log, for it is obvious that crooked logs mean considerable sawmill waste in slabs. If it is possible to cut a log of clear length (without limbs), do so, and throw all the limbs into the second log, for clear lumber free from knots is most valuable.

What has been said for logs pertains also to other products. Use your head as well as your axe or saw,—know what products are best, and make them. Every branch of forestry, whether it be called silviculture, scientific management, or "cutting wood," involves the application of good old common sense.

Hauling.—After cutting, products must be hauled to the place of disposal or use. Where they cannot be loaded on wagons or trucks where they fall, they must be dragged or "skidded out" to the nearest opening or road. Horses are ordinarily used for this work. If roads are good and the haul is long, motor trucks are frequently preferable to horses and wagons. The operator must figure out the merits of each for himself, as it all depends upon local conditions.

Remember that the more often products are handled and the longer the haul, the greater the expense and the smaller the profits. Keep these cost items down to a minimum. Operators, disposing of large quantities of cordwood, ties, props and other small sized products, will do well to consider the use of an economical motor-truck with trailers. A truck with several trailers seems to be a good combination; for instance, one loaded truck and trailer on the road, one trailer in the woods being loaded and one trailer at the destination being unloaded. The truck is more constantly on the move and this lowers a big item of expense.

In regions where snow is abundant hauling with sleds is most economical.

Seasoning and Storing Products.—When products are not sold or used immediately they should be carefully piled to prevent loss from decay or insects. For most purposes wood should be seasoned before being used. Green posts decay more rapidly than seasoned posts; wet cordwood doesn't burn as well as that thoroughly dried; green lumber shrinks and warps. Dry, seasoned wood is considerably lighter in weight than fresh cut, green timber, and therefore cheaper to haul or ship and easier to handle. Wood commonly loses one-third to one-half of its green weight when thoroughly air dried and even more when kiln dried.

Products should be stored under cover where practical as they will dry better and be less liable to decay and damage. But remember to keep down the cost of hauling and handling. If piled in the woods, consider the possibility of loss from forest fires, or better still, take every precaution to guard against this menace.

Wood decays most readily in warm and damp situations, especially in contact with the ground. To season wood, always pile it on "skids" (poles) at least a few inches off the ground, and in loose piles with small sticks between layers to induce free circulation of air. This latter precaution is not necessary in the case of loose piles of wood like cordwood.

Wood boring insects sometimes damage stored products, but attacks are least likely to occur if the bark is peeled. Removing the bark also hastens seasoning. Posts, poles, ties—in fact all products which will come into contact with the ground—should be peeled. Bark peels most easily on trees freshly cut in the spring or early summer, when the sap is rising, but for other reasons it is rarely advisable to cut at this time. (See page 39.)

Wood usually splits most easily when green, and split cordwood and fence posts season faster than when left in the round. Drying at a slow, uniform rate tends to prevent checking of timber (splitting at the ends). Wood decays least and is not subject to insect attack in cold weather. Wood seasons faster in hot weather.

SLASH DISPOSAL

Logging slash is a menace to woodlands and should not be tolerated. It not only invites forest fires, but provides the fuel for a hot, destructive fire when one does occur. Dead wood is a common breeding place for fungus diseases and insects. Slash interferes with woods work and is unsightly, a reason for its disposal if the aesthetic value of the woods is important.

When a tract of timber is properly cut and thoroughly utilized, there will not be much slash left on the ground, especially if cordwood is one of the products, for cordwood commonly untilizes everything down to 2 inches or less in diameter. A crowded stand of small crowned trees will leave less slash than those with large crowns.

Lopping Tops.—If slash is lopped into small limbs which will lie flat, close to the ground, it will be pressed down by snow and will soon decay. Slash treated in this manner is seldom a menace more than two or three years. Brush allowed to remain off the ground will season and resist decay for a long time.

If brush cannot be lopped and scattered conveniently without interfering

with young growth or constituting a dangerous fire menace, it may be lopped and gathered in small compact piles in convenient openings.

Burning Slash.—In especially dangerous areas where forest fires are likely to occur, as along roads, railroads, near sawmills or buildings, slash should be piled in openings and burned. Care should be taken to burn where the least damage will be inflicted to standing trees, and at a time when there is the least danger of the fire escaping. Slash should never be burned in a dangerous season for forest fires. The best time is just after a light snowfall, not wet or heavy enough to prevent the brush burning, but enough to guarantee safety. Burning slash and brush is slow work, costly and dangerous and should not be undertaken except where absolutely necessary.

New Jersey's Forest Fire Law requires that a written permit must be secured from the local Firewarden for setting *any* fire in woodland, or within 200 feet of any woodland or any growth which may carry fire to woodland, in any town, township or borough in which Firewardens have been appointed. The State Firewarden also has the authority to compel owners to clean up slash where it is a dangerous forest fire menace.

Copies of the law and lists of Firewardens may be secured upon application to the State Firewarden or State Forester, Trenton.

FOREST PLANTING

The need for planting is not so great in New Jersey as in many other sections of the country where natural forests are lacking or where forest growth has been almost entirely destroyed. Forests should be encouraged to reproduce themselves naturally wherever possible, because it is ordinarily easier and less costly than artificial reforestation—planting. The greater part of New Jersey's two million acres of woodland will grow good forests if properly protected from fire and cared for intelligently. Forest planting is advisable on non-agricultural land desired for timber production where natural growth is inferior, undesirable, insufficient or lacking altogether.

WHERE TO PLANT

Abandoned Fields.—Scattered throughout the State there are thousands of acres of idle fields, formerly cleared for agriculture and abandoned by their owners because they have proven unprofitable for farming. In many instances the soil is not fertile enough to raise good agricultural crops; in other cases the soil is fertile, but so steep that it erodes badly; or it may be too rocky or too wet for farming. Lying idle, these fields are a liability to their owners. They can be made productive, and a profitable asset, by planting trees. Occasionally abandoned fields revert to forest growth naturally from seed scattered by surrounding trees, which makes planting unnecessary if the natural reproduction is sufficient in quantity and of satisfactory species. If not, the natural growth should be supplemented with planted trees.

Burned woodlands, where the timber has been killed by forest fires, or so badly damaged that natural reproduction cannot produce a satisfactory new stand of timber, is another situation where forest planting is advisable. It may be that natural seeding or sprouting is not possible, or at best very slow and unsatisfactory, or that the better species have been killed off, and only inferior species are left to reproduce naturally. Weed trees, like weed plants, are hardest to kill off and grow under conditions that discourage better species. Scrub oak, fire cherry, red maple, gray birch and similar inferior species of little commercial value, are the ones which commonly come in naturally after a bad burn. South Jersey pine usually sprouts after a fire, but the sprouts do not make good trees. Under such conditions, where natural reproduction is either lacking, insufficient, or of inferior quality, forest planting is recommended, provided there is reasonable assurance that the fire will not be repeated after the plantation becomes established.

Woodland denuded by careless lumbering is frequently unable to reproduce itself satisfactorily, either as regards the abundance or quality of the species. As in the case of burned woods, planting is sometimes the best and quickest means of assuring another profitable timber crop. Where competition with inferior natural growth is likely to be harmful to the planted trees a cutting at the right time will give the planted trees at least an equal opportunity to establish themselves.

Under-planting must frequently be resorted to, to fill in gaps in estab-

Young pines planted on good land not suited to agricultural crops because of its tendency to wash.

Forest plantations on worn-out, abandoned fields not fit for farming.

There are thousands of acres of abandoned fields in New Jersey that never should have been cleared. They can be put to profitable work growing forest trees. Until this is done they will remain idle and unproductive.

lished forests where there are large openings or where there are not enough trees present to fully occupy the ground. No forest is fully productive unless the land is completely occupied by the best trees. In old groves natural reproduction is often prevented by shade, or by a grass sod covering the ground. Where grazing has been permitted in woodlots, the animals have usually destroyed seedlings by eating or trampling and planting is often necessary to fill gaps or to start a new crop.

Special timber crops must be grown from planted trees if they cannot be obtained from natural forests. With the scarcity and increasing cost of many kinds of timber, wood-using industries and users of certain products are finding it advisable to assure a future supply of special woods to fill their needs. Users of railroad ties, poles, posts, and similar durable woods, the natural local supply of which is becoming exhausted, will often find it good business to grow them for the future. The same is true of users of basket logs, cooperage stock, boxboards and other similar products. Many persons are finding Christmas trees a profitable crop that can be grown from planted trees in a short time.

Farm Timber.—A woodlot is an important part of a farm. It supplies wood for many purposes—cordwood, fence posts, building timbers, lumber, etc. There are frequently wet, rocky or steep fields that are not suitable for cultivation, and are less valuable for pasture than for timber growing. Owners will find it advisable to plant forest trees on such land, not only to supply their own needs, but to grow timber for profitable sale.

WHAT TO PLANT

Species adapted to conditions of soil, moisture, exposure and climate must be chosen for planting, if success is to be had. For instance, tulip poplar and white ash must have a fairly fertile, moist soil; loblolly pine will not succeed in the North Jersey climate; chestnut cannot be expected to live as long as the blight is present. It is always safe to plant species that grow well nearby under similar conditions.

Species suited for the products desired should be planted if the planter has any special needs, or wants to raise any particular crops. The table on page 50 shows the best species for certain products, adapted to the kinds of soils common in New Jersey. Further information regarding the uses of trees is found on pages 61 to 77.

Hardwoods or Evergreens.—There are situations where it is desirable to plant hardwood species but in general it can be said that evergreens (conifers) such as pine and spruce will yield more timber and more profit per acre in a given time than hardwoods. Evergreens are better adapted to poor soils and make better growth there than hardwoods; ordinarily poor soils are those which will be planted.

Pure or Mixed Plantations.—Many foresters advocate mixed plantations (two or more species) upon the ground that it is Nature's way, that one species helps another, that insects and disease do less harm, if an attack occurs, than in pure (one species) forests. These arguments have weight,

Black Locusts, 12 years old, large enough for fence posts.

Norway Spruce, 11 years old, 8 years after planting. These trees were big enough for Christmas trees 4 years ago.

A planter doesn't have to wait a lifetime for profits as so many persons believe. Most species make fast growth on Jersey soils. Poor farm land may be good forest land.

yet it is usually easier and often better to plant comparatively small groups of from one to several acres of a single species, each group representing the fittest tree when climate, soil, markets and all other factors are considered. A mixture of species is sometimes advisable, as for instance, where it is desired to grow a short time crop, such as Christmas trees or fence posts, to be removed at an early period as a thinning, leaving the remainder to grow to sawlog size. Planting black locust in mixture with other species lessens the danger of an attack by the locust borer.

Quick Growing Trees.—Other things being equal, by all means use the species that will give quickest returns, but bear in mind that rapid growth is usually a response to stimulation through fertile soil, abundant moisture and favorable climate. Most species grow well under suitable conditions; even the best will grow slowly under unfavorable circumstances. Many rapid growing species lack in quality of wood what they gain in quantity, yet for certain products such as pulpwood, cordwood, boxboards, etc., quick growth of a large quantity of comparatively low quality wood is usually most profitable.

Nut Trees.—Fair crops of nuts may be, and often are, produced by forest trees. However, nut culture is not forestry, but a branch of horticulture, like fruit growing. A tree developed for nuts has too much crown to produce good lumber; one grown tall and straight for lumber has too little crown to yield much fruit. Dismiss, therefore, all thought of combining the two crops. Let fruit (including nuts) be grown where that is likely to be profitable and where the trees can be given the care they need. Trees for lumber are satisfied with poorer soil and much less care.

Species Not Recommended.—A few species unfit for economic planting in New Jersey have been so persistantly boomed that their real qualities should be known.

Catalpa grows very rapidly on rich, moist soil and in a mild climate. In North Jersey its late growth is apt to be frozen; in South Jersey only the best agricultural soils are fit. Its wood is valuable chiefly for posts and poles, being very durable, but weak.

Walnut wood is valuable only when cut from the heart of large, old trees. A tree 40 years old might be 12 inches in diameter, yet contain only a 4-inch cylinder of dark heart wood. The sapwood of young black walnut is very wide, light in color and practically unmarketable. Moreover, walnut demands for good growth soils so fertile that farm crops would undoubtedly bring in bigger profits from the same land. The proper place for planting walnut is around the farm buildings or along roads and lanes, where shade is wanted. Several highly advertised hybrid varieties of black walnut are believed to be unsuited to our climate.

Other species, such as hard maple, beech, hemlock, etc., are slow in growth and not particularly valuable for lumber, so are not recommended for general forest planting, although they are sometimes desired for their aesthetic value.

SPECIES RECOMMENDED FOR PLANTING

GROUPED ACCORDING TO SOILS AND PRODUCTS.

PRODUCTS DESIRED.	GOOD SOILS Fairly fertile, moist but well-drained. May be rocky or steep.		MEDIUM SOILS Exhausted or unfit for agriculture.		POOR DRY SOILS Sandy, stony or rocky. Very little humus or fertility.		WET SOILS Poorly drained. Wet at certain seasons.	
	North Jersey	South Jersey	North Jersey *Abandoned fields*	South Jersey *Natural oak land*	North Jersey *Dry, rocky slopes and ridges*	South Jersey *Natural pitch pine land*	North Jersey	South Jersey
Logs, lumber, or products made from logs or lumber	Red pine Norway spruce Tulip poplar White ash Hickory Red oak Cottonwood Any other species	Loblolly pine Red pine Shortleaf pine Tulip poplar Red oak Cottonwood etc.	Red pine Norway spruce Scotch pine Red oak	Loblolly pine Red pine Shortleaf pine Scotch pine Red oak	Scotch pine Pitch pine	Scotch pine Shortleaf pine Pitch pine	Cottonwood Elm Ash Basswood Balsam fir Norway spruce	Cottonwood Red gum Norway spruce
Electric Poles	European larch Douglas fir Red pine	European larch Shortleaf pine Douglas fir Red pine	European larch Douglas fir Red pine	European larch Shortleaf pine Douglas fir Red pine				
Ties and Posts	Black locust European larch White oak Red oak	Black locust European larch White oak Red oak	Black locust European larch Red oak Chestnut oak	Black locust European larch Red oak Chestnut oak	Chestnut oak Red cedar Scotch pine	Scotch pine Shortleaf pine Pitch pine		
Christmas trees	Norway spruce Balsam fir Douglas fir	Norway spruce Douglas fir	Norway spruce Balsam fir Douglas fir	Norway spruce Douglas fir	Norway spruce	Norway spruce	Balsam fir Norway spruce	Norway spruce
Windbreaks	Norway spruce Douglas fir Hemlock Arborvitae Red pine Scotch pine	Norway spruce Douglas fir Red pine Scotch pine	Norway spruce Douglas fir Red pine Scotch pine	Norway spruce Douglas fir Red pine Scotch pine	Scotch pine	Scotch pine	Hemlock Arborvitae Norway spruce	Norway spruce

NOTES. (1) White pine is valuable for the same uses as Red pine and grows well under similar conditions, but is not recommended for extensive planting at present because of the danger of the Blister Rust disease.

(2) Douglas fir, Balsam fir, Arborvitae, European larch and Loblolly pine are not native species; tamarack and black spruce have only limited occurrence in New Jersey. The planting of these species is still in the experimental stage, yet it is believed that they will suceeed where recommended for planting.

HOW TO PLANT

Season to Plant.—In New Jersey, early spring as soon as the frost is out of the ground and before the buds open, is best. The planting period usually lasts two or three weeks during April or early May, depending upon the season. Deciduous trees should never be taken from the ground while their leaves are on. Evergreens can be, and often are, planted successfully in late summer and early fall, but there is always danger that winter winds, often very drying, will put too great a strain upon the weakened root system of any tree moved in the fall. There is also more danger of "heaving," as the ground freezes and thaws, if trees are planted in the fall. Cloudy or wet weather is always better than bright sunshine for planting.

Young Trees More Satisfactory Than Sowing Seed.—The lowest initial cost is found when seeds are sown on the ground, yet neither this method nor planting the seeds in prepared spots ordinarily give good results. In Nature probably less than one seed in a thousand ever makes a tree. Birds, mice, dry weather and many other adverse influences make it advisable to plant sturdy young trees.

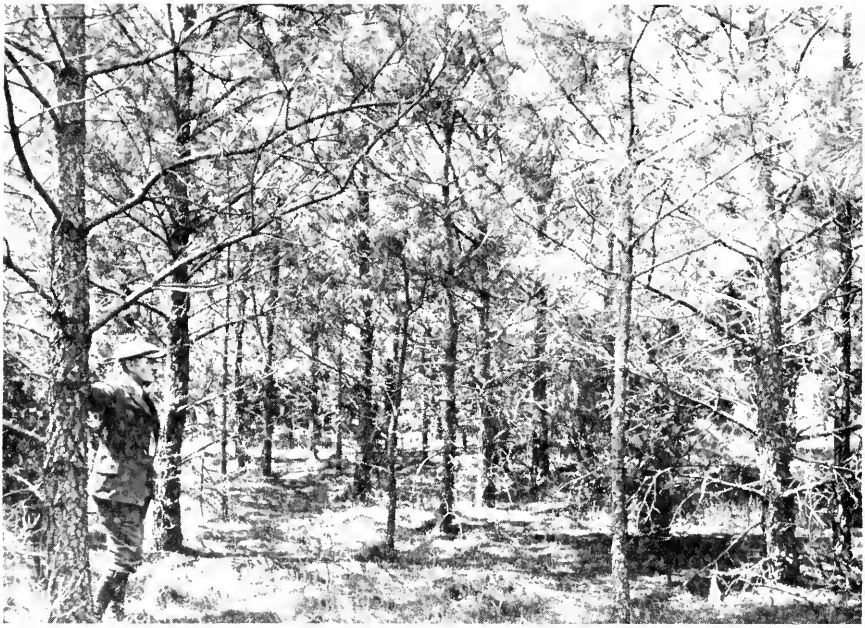
Size of Trees.—Small seedlings are most economical and are usually satisfactory. They are less expensive to grow or buy than larger trees and cost less to handle in planting. Hardwood (deciduous) seedlings are easiest handled when one year old; the size and root development of older trees makes their use rarely advisable.

Two year old seedlings of conifers (evergreens) with stems from 4 to 6 inches high, are best and cheapest to use in planting old fields or cleared areas where conditions are favorable. If competition with a thick growth of sod, weeds or other trees is excessive, larger trees—three or four years old, transplanted from the seed bed—are better, since they have better developed root systems, and establish themselves more quickly among unfavorable surroundings. Since they are more expensive to grow or buy and cost more to handle than two year seedlings, their use should be avoided if possible.

A home nursery is not advised unless a very large area is to be planted. The growing of evergreens, in particular, requires much skill, and except in rare instances it will be found less costly and more satisfactory to buy planting stock from the nurseries specializing in large quantities of small sized seedlings especially for forest planting. If conditions make it necessary to use large transplants, it is sometimes advisable to buy one or two year old seedlings and transplant them for a year or two in the home garden.

Anybody contemplating a home nursery should get complete information and expert advice before starting, as it is by no means a simple undertaking.

Use of Wild Stock.—The transplanting of wild, forest grown seedlings to the forest plantation commonly costs more than buying better seedlings from a nursery, and is not so satisfactory. Unless very young wild seedlings are secured (one or two years old) their roots will have developed to such an extent that they will be damaged by moving unless the work is very carefully done. Damaged roots mean a setback and resultant slow growth after transplanting.



An experimental plantation of Loblolly pine on a South Jersey State Forest, with many of the 15 year old trees 9 inches in diameter, fit for boxboards 12 years after planting.

A mixed pine and spruce plantation in Warren County that yielded 19,000 board feet of sawlogs per acre at 35 years of age.

Short rotations of fast growing trees are often most profitable. Small logs for boxboards and similar products can be grown in from 20 to 40 years. It requires 60 years or more to grow large trees fit for high grade lumber.

Where to Get Trees.—The State of New Jersey grows no planting stock for public distribution. Young trees can be obtained from many nurserymen, although as a rule those who handle ornamental stock do not have the large quantities that are wanted for forest planting, or are not prepared to make the price low enough.

If prices are the same, buyers are recommended to satisfy their needs from reliable nurseries nearest the planting site, or from those which will deliver the stock so that it shall be the shortest time out of the ground. In all cases it is advisable to stipulate that stock shall be taken from the ground of the vendor—not assembled from other nurseries, and that it shall have been subject to State inspection, and guaranteed to be free from dangerous insects and disease. Prices should be based upon size, not upon age alone.

Orders for planting stock should be placed during the fall or winter if possible, and at least several weeks before the planting season, to ensure getting the species and size desired. Specify delivery a few days or a week earlier than the probable earliest date of planting.

The State Forester will furnish upon request a list of nurseries where young trees can be obtained, and will assist in placing orders.

How to Handle Trees Before Planting.—When a tree is out of the ground its roots must never become dry. It is especially important to guard evergreens since the foliage is active at all times and the draught upon the root moisture is therefore constant. Deciduous trees without leaves are less sensitive; in foliage they should never be moved.

Nurserymen ordinarily ship young trees by parcel post or express with the roots well packed and moist. As soon as the package is received open it, and thoroughly wet the contents. If planting is to be delayed more than 48 hours, *heel in* the plants until wanted.

Heeling in means putting the trees in the ground temporarily so that the roots shall not become dry before they can be regularly planted. Dig a trench in well-shaded, moist soil, a little deeper than the length of the tree roots, with one side of the trench at about a 45° slope. Spread the trees or small bundles of trees in the trench along this slope with the tops up, and cover the roots and lower stems with moist earth firmly tamped down. Keep the roots straight and spread out. Successive layers of trees may be put in the trench, with two or three inches of earth between. Be careful not to cover any of the foliage of evergreens with earth. If dry weather comes, wet the earth, but not often enough to cause heating. Trees of any kind can be kept in this way for several days without injury.

Preparing the Ground.—As every cost item in growing a forest must be carried as an investment at compound interest until the timber is mature, it is important to save every possible expense. Though trees undoubtedly grow better when planted in prepared and fertilized soil, it is usually advisable to omit everything of the kind on account of the cost. Forest trees will succeed on land too poor for other crops. If the ground is very weedy or covered with low brush, it may be mowed or burned over before planting. When trees are to be planted among thick, high brush, it is sometimes necessary to clear out a space around each planting spot, to give the tree a better

opportunity to start. On fields with a very heavy sod, trees may be planted in a shallow furrow plowed along each row.

Light Requirements.—In forest planting, as in every branch of silviculture, the innate qualities of each tree species with respect to sunlight must be considered. Some kinds, such as pine, ash, tulip and cottonwood will endure little shade from other trees and therefore must not be crowded. They are called light requiring or intolerant. Others such as spruce and fir are less particular and are called shade enduring or tolerant. Tolerant trees, when well grown, always have more branches than intolerant trees, but more of them can thrive on a given area. An intolerant species must never be planted where it will lack sufficient light. This fact must be considered in underplanting in woods already established, in plantations of mixed species, or on cutover lands where the planted seedlings must compete with natural growth of seedlings and sprouts from stumps.

Spacing.—The proper interval between planted trees depends chiefly upon the habits of the species and the expected life of the plantation. Grown for timber the trees should be close enough to crowd each other at an early age, so that they will grow straight, tall, and free from lower branches. When this crowding becomes excessive, thinnings can be made as in the case of crowded natural woods. (See pages 19 to 34.) The common practice is to plant trees six feet apart each way. Cottonwood should have a little more room, Norway spruce a little less. Species intolerant of shade must not be crowded too much, but care must also be taken less the trees are too far apart, and become bushy and limby.

Another common practice is to plant alternate trees of two species rather close together, one species to be removed at an early age for some small sized products that can be profitably disposed of. For example, spruce and pine can be alternated four feet apart, the spruce to be removed within 10 years for Christmas trees, the pine left to grow to timber size.

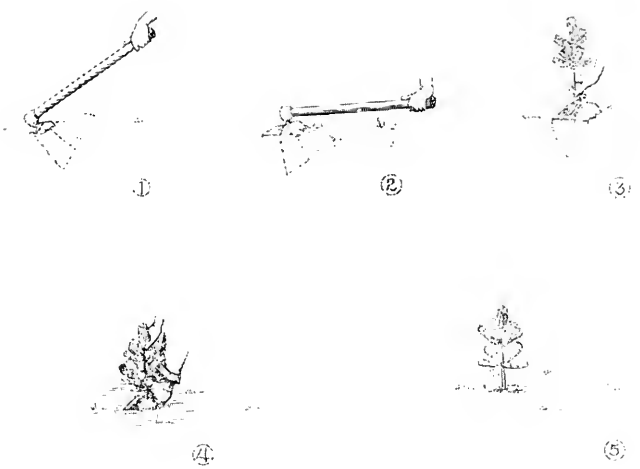
TREES PER ACRE AT VARIOUS SPACINGS.

3	feet	x	3	feet	4840	trees	per	acre
4	"	x	4	"	2722	"	"	"
5	"	x	5	"	1742	"	"	"
6	"	x	6	"	1210	"	"	"
8	"	x	8	"	680	"	"	"
10	"	x	10	"	435	"	"	"

Care of Seedlings While Planting.—When ready to plant, mix a "puddle" or thin paste of mud (clay) and water, in which the roots of the seedlings are immersed to keep them from drying out. Several hundred seedlings can be carried to the planting site in a pail containing a few inches of this "puddle", or after the roots have been coated with the paste the seedlings can be carried in a basket lined with wet moss or burlap. *Don't let the roots dry out.*

Planting.—Ordinarily the best tool for planting is a mattock or grubbing hoe. A small hole is made with the least possible effort—just large enough

THE CORRECT WAY TO PLANT TREE SEEDLINGS



The most important points to remember are: make the hole large enough to take the roots without cramping; press the earth firmly around the roots. Don't let them dry out.

to contain the roots without cramping or crowding. Sometimes spades or other tools are preferable to mattocks—it all depends upon soil conditions, the ground cover, and the worker. If the turf is close or weeds very dense, "scalp" a square foot or so of ground where each tree is to stand. A shallow plowed furrow along the line of each row of trees sometimes makes planting easier where there is a heavy sod.

Important Directions to Follow.—1. Keep the cost down. Prepare the ground and holes for planting with the least possible effort and expense. Do only what is necessary to assure success.

2. Don't let the roots dry out.

3. Plant in cloudy or rainy weather if possible, but don't delay too long, as this is not essential.

4. Be sure the tree roots are spread out straight in the hole, and are not cramped, crooked, or bunched.

5. Be sure that the loose earth is tamped back firmly around the roots.

6. Don't bury any of the seedling's foliage in the earth. Set each tree very little if any lower in the ground than it was in the nursery.

Planting crews of two or three men are probably most efficient. Let one man dig the holes, followed by a man who places a seedling in proper position in each hole and firms the earth back around the roots. Sometimes it is helpful to have the seedlings distributed by a man or boy, so that the planter has nothing to carry to interfere with his work. When this is done, the

seedlings should not be left lying on the ground long enough for the roots to dry out. If one man is working alone he can first prepare a number of holes and then come back and put in the trees.

Lining and Spacing.— Where it is desirable to have the rows as straight and the trees as evenly spaced as possible, it is an easy matter to set guide stakes along the boundarys of the plantation to keep the planters in line. It is always well to keep the spacing approximately even as then each tree has equal growing room and when thinning is necessary later on, it is more easily done. Usually it is not advisable to spend much time providing absolutely straight rows. On areas covered with patches of brush, or already partly occupied by trees, advantage must be taken of openings where the young seedlings will be hampered as little as possible by surrounding and competing growth. Under such conditions it is of course impracticable to keep the rows straight and the spacing even. Never plant a seedling under brush or other trees if it can be planted in an opening between.

SUBSEQUENT CARE

Little Attention Needed.—A forest plantation ordinarily needs no cultivation and little special care. Fires must be kept out, of course, and live stock must not be permitted to graze for they injure and kill seedlings by trampling even when they do not eat them. No expense for cultivation is warranted unless more than the economic production of lumber is involved. Harmful insects and tree diseases sometimes attack plantations, but ordinarily can be readily checked. (See page 85.)

Replacement.—If as many as 30 per cent of the trees die, the gaps should be filled within two years. If the loss is less, and fairly well distributed, this is generally not necessary.

Cutting Back.—When the growth of *hardwoods* is slow, or when they have been injured in any way after planting, growth can be stimulated by cutting off each young tree just above the ground early in the growing season (spring or early summer.) The succeeding shoot is stronger and ultimately taller than the original would have been. Conifers (evergreens) should never be cut back, for removing or injuring the leader destroys the form of the tree.

Cleaning.—When a plantation is 5 or 10 years old, sometimes earlier, it may be necessary to cut out competing weed trees, high brush and other undesirables. This should be done only when such growth interferes with the upward development (height growth) of the planted tree. Keep the crowns of the young trees free to the sunlight; let low growing brush and weeds alone, for they stimulate height growth, shade the ground and conserve moisture.

Pruning limbs is ordinarily not necessary, since this is done by Nature in a properly planted forest. Limbs make knots and knots make low grade lumber; therefore tall, straight trunks free from limbs are wanted. That is why the trees are planted so close together. In the average plantation of pine, spaced 6 feet by 6 feet, the crowns of the trees will touch each other

within 10 years after planting. This overhead canopy of shade kills off the lower limbs, and within 3 or 4 years the dead limbs drop off. This is natural pruning. Where lower limbs do not prune well naturally, they may be cut or knocked off as high up as a man can reach with an axe. The expense of this work should be avoided if possible by providing conditions suitable for natural pruning.

Many persons become concerned over the death of these lower branches, and fear that their plantation is too thick, especially when crowded trees die here and there. There is no cause for alarm. To force height growth and clean trunks the plantation must be dense, and the crowding process will necessarily kill many trees. But remember that where 1200 trees are planted on an acre, not over half this number should be left standing at 25 years of age, and at 50 years only about one-third or one-quarter of the trees should be left.

Thinning.—Ordinarily plantations made as herein described will need no thinning until 20 years or more of age. When improvement cuttings are necessary, proceed as in the case of any similar crowded, natural forest. (See pages 19 to 34.)

COSTS AND PROFITS OF PLANTING

Cost of Labor.—Under average conditions of planting on old fields, two men can plant from 1000 to 1500 trees per eight hour day—more or less depending upon soil conditions, ground cover, size of seedlings, and the experience and ability of the planters. Six foot spacing gives 1210 trees per acre; therefore two men will ordinarily plant a little more than an acre a day. At prevailing wages (1922) this means an average cost of from $4 to $6 per acre for labor. This cost will be higher or lower according to the spacing and number of trees planted per acre.

Cost of Trees.—The cost of nursery stock has been abnormally high during the period of the World War and the years immediately following, but with the passing of unsettled conditions, prices are again becoming normal. Two year old seedlings of many of the most desirable coniferous species now (1922) cost from $4 to $10 per thousand and within a year or two prices may be even lower. One year seedlings of many hardwood species can be bought for less than $10 per thousand, some as low as $2.50 per thousand. Three and four year old coniferous transplants are more expensive and can rarely be purchased for less than $10 or $15 per thousand, and they frequently cost more. This high cost ordinarily prevents their use in forest planting.

Cost of Average Plantations.—The cost of planting an acre of trees varies, as has been explained above, according to conditions. The seedlings and the labor for a plantation of trees spaced 6 feet apart, will ordinarily cost from $8 to $15 per acre, and will average about $10 to $12. The average plantation with trees spaced 8 feet apart will cost about $6 per acre; with 5 foot spacing, $15; with 4 foot spacing, about $25.

When the planter desires to keep strict account of all costs, as is done in business, he must figure the value of his land, the cost of planting, taxes,

care and protection, at compound interest for the period of years required to mature the crop. For example, with land worth $5 per acre and an initial planting cost of $10 per acre, the cost (including taxes) of carrying the plantation at 4 per cent compound interest for 30 years would be about $60; for 40 years, about $90; for 50 years, about $135. In other words, this is what the amount of his original investment would increase to in the bank at compound interest. For simplicity only the initial costs and taxes are considered, although there would probably be some small intermediate costs, as well as some income from thinnings. The latter, however, should more than balance the former. Where abandoned fields are planted, it is questionable whether the land value is fairly considered as an item of cost. The owner has this idle land on his hands, it is valueless for farming, and is usually unsalable.

Profits from Plantations.—Forestry, including forest planting, is by no means a get-rich-quick proposition, but it pays fair profits and utilizes otherwise waste land. Moderate returns are better than nothing at all. It requires little capital and only a small initial investment; the returns are sure and steady and will ordinarily net a profit on the original investment of at least 6 per cent to 10 per cent or more, as timber values increase.

Neither does forestry involve waiting a life time for profits, as so many persons believe. Properly undertaken, a plantation should begin to yield an income in from 6 to 20 years, and at intervals of from 5 to 10 years apart thereafter. The mature crop can usually be harvested in from 30 to 60 years. Moreover, as timber becomes scarcer, a young, thrifty, immature forest will have a sale value, just as a fruit orchard not yet in bearing, has. The value of an immature forest may be determined by discounting the ultimate value at maturity back to the present time.

Ordinarily in estimating the probable profits of forestry, the value of the ultimate yield is based upon the *present stumpage value* of the expected crop,—that is, what the trees would be worth if standing in the forest at the present time, at present prices. This estimate of value is ultra-conservative, for timber values are steadily increasing. Moreover, since an owner can readily cut and market his crop, if he desires, it is only fair to consider him entitled to the profit of this work, which will usually be at least equal to the stumpage value of the crop. A fruit-grower figures his profits on a crop of apples picked and packed, rather than growing in the orchard. A farmer values his crops the same way. So should the timber grower.

Expected Yields and Profits.—A plantation of pine on fairly good forest soils, which may be unfit for profitable farming, will ordinarily yield 20 thousand board feet of sawlogs per acre in 40 years, worth $200 standing in the forest at present stumpage prices, or about 6 per cent profit on the original investment. But 40 years from now timber stumpage may easily be worth twice as much as at present, or even more;—values are sure to increase considerably as timber becomes scarcer. Furthermore, this timber now worth $200 per acre standing in the forest, is worth at least $400 cut into logs and delivered at a sawmill or manufacturing plant. For example, lumber worth $50 a thousand board feet is sawed from trees valued at about $10

per thousand board feet stumpage. The average charge for custom sawing logs delivered at the mill in New Jersey is about $12.50 per thousand board feet. The cost of cutting and hauling the logs rarely exceeds $10 per thousand board feet, and may be considerably less for short hauls. In other words, the average cost of producing $50 worth of lumber ordinarily does not exceed $32.50, including the stumpage value. There remains considerable profit for those who do the work. The stumpage owner—the planter or the woodlot owner—may partake of these profits if he will.

The same plantation described above may be expected to yield at least 25 thousand board feet in 50 years, or 30 thousand feet in 60 years. The cost of carrying the plantation longer than 40 years will increase as the compound interest charged to the original investment, but the timber will be worth more because the crop will be larger and its quality better. On poor forest soils the yields will be less, of course, but it should be remembered that poor *agricultural* land may be excellent for growing timber, and that really poor *forest* soils are ordinarily restricted to dry, rocky ridge tops, very wet swamps, or unusually sterile areas of the South Jersey sands.

An acre of fairly strong, moist but well drained soil planted to black locust should yield at least 2000 of the most durable fence posts, besides a quantity of fuel wood from tops and limbs, in from 15 to 25 years. After the trees become established the plantation may be used for a chicken yard or similar use, for which the shade and protection of the trees is an advantage. Locust planted in 1907 on good soil at the Agricultural Experiment Station farms near New Brunswick was satisfactorily used for a chicken run, and in 1918, after 12 years' growth, trees 40 feet tall and from 4 to 6 inches in diameter were cut for posts. (See illustration, page 48.) In from 25 to 35 years an acre of locust growing under favorable conditions should yield at least 400 railroad ties, 1000 to 1500 fence posts, and a quantity of cordwood. Locust ties now sell for $1.25 to $1.50 per tie, and locust fence posts are worth from 25 to 50 cents each. These prices will undoubtedly increase as chestnut becomes exhausted. The cost of planting an acre of locust should not exceed $8 for labor and seedlings.

An acre of spruce, or spruce and pine, planted with 4-foot spacing (2700 trees per acre) costs not over $25 to establish, and should yield from 1000 to 1500 Christmas trees from spruce thinnings in from 6 to 12 years, leaving enough trees of pine or spruce to produce 20 thousand board feet of timber in 40 years, or 30 thousand board feet in 60 years. Christmas trees of this size now retail at from 50 cents to $2.00 each.

A planter in Morris County has sold more than $2000 worth of young trees to his neighbors for ornamental planting and removed only the crowded trees that would have ultimately been lost. Enough trees still remain to produce a good stand of timber. This plantation of several acres originally cost about $300 to establish.

During the period of the World War labor conditions forced a municipal Water Department in Essex County to neglect its forest nursery temporarily, and as a result many pines and spruces became too large for economical use in their forest plantations. This nursery originally cost less than $100 to

establish. In the spring of 1922 more than $1000 worth of crowding young trees were sold on the ground to persons who came and dug them for ornamental planting.

This sale of young trees from forest plantations offers a very profitable market for "thinnings," but it should be remembered that the trees do not have the closely bunched root systems of trees frequently transplanted in a commercial nursery, and cannot be expected to compete with them as regards quality. Consequently they must be carefully removed with a good ball of earth attached to the roots and at an early age to succeed after replanting.

HELPFUL INFORMATION

CHARACTERISTICS AND USES OF FOREST TREES

An understanding of the characteristics and uses of trees is necessary for anyone who would work his woods intelligently. New Jersey forest regions, their location, extent and composition, have already been described on pages 3 to 6. The following description includes most native trees and exotic species recommended for planting, but does not attempt to give more than the chief characteristics and uses of each. Bear in mind that the growth habits of a species vary considerably according to conditions.

Hardwoods and Evergreens.—Our native trees are divided into two classes, hardwoods and evergreens. The broad-leaved foliage of the hardwoods is deciduous,—that is, the leaves fall in the autumn. The evergreens have needle-like leaves which usually remain green on the trees throughout the year. They are also called conifers, because their fruits are cones. The wood of evergreens is usually softer than that of hardwoods, although there are exceptions, and it also differs from hardwoods in that it is resinous.

HARDWOODS OR DECIDUOUS SPECIES

OAK

White oak (*Quercus alba*) is one of our most valuable, important and abundant hardwoods and is found in all parts of the State, although in South Jersey it rarely occurs on the poorer soils. Its hard, strong, fairly durable wood is the standard of excellence among oaks. It has a wide range of uses, including furniture, ships, vehicles, interior finish of houses, agricultural and other implements, cooperage, baskets, piling, ties, posts, and cordwood. White oak reproduces well naturally either from seeds or sprouts, and makes moderate growth on fairly strong, well-drained soils, but does not tolerate dense shade. It is one of the best trees to favor where growing conditions are suitable.

Red oak (*Quercus rubra*) is similar to white oak in most of its characteristics, habits and uses. Its valuable lumber is only slightly inferior to that of white oak, although it is less durable for ties or posts unless creosoted. Red oak usually grows more rapidly than white oak and therefore is preferred for planting, especially on soils of moderate fertility.

Chestnut oak (*Quercus prinus*) is of considerable value in New Jersey woodlands, for it thrives on dry, rocky ridges or sands too poor to grow most other trees successfully. In such situations the form of the tree is apt to be crooked and growth slow, but it should be favored because it is the best tree for the site. Its lumber is similar to that of white oak, and is used chiefly for ties, posts and cordwood.

There are many other native oaks of some importance. **Swamp White oak** (*Quercus platanoides*), **Post oak** (*Quercus minor*) and **Bur oak** (*Quercus macrocarpa*) resemble white oak in many respects, but are less important because less abundant. **Black oak** (*Quercus velutina*), **Scarlet oak** (*Quercus coccinea*) and **Pin oak** (*Quercus palustris*) are similar to red oak, although somewhat inferior in quality of lumber. Pin oak commonly inhabits wet situations, and is used chiefly for piling. Its lumber is very knotty, due to numerous small limbs which persist well down the trunks. The scrub oaks, several species of which are found on barren, rocky ridges in North Jersey and mixed with pine on the poorer sands of South Jersey are the only oaks that are not valuable. Many misinformed persons refer to all South Jersey oak as "scrub oak", which is wrong, as many of the most valuable species make good growth in this region when protected from fire, though recently cut-over areas covered with young sprouts do look rather "scrubby" for the first few years.

HICKORY

Hickory has been called the indispensable wood because for some purposes no other can fill its place. It is very heavy, very hard, very strong, tough and flexible, qualities which make it valuable for vehicle parts, tool handles and agricultural implements. It makes excellent fuel, and is often used in curing meats. The wood decays rapidly in the ground or when exposed to the weather.

Shagbark hickory (*Hicoria ovata*) whose fruit is the common hickory nut in the markets, and **Pignut hickory** (*Hicoria glabra*) are our most common and important native species. They are found in all parts of the hardwood region on the better soils, especially those that are moist but well drained. While hickory is usually of rather slow growth, and quite exacting in its soil requirements, it is one of the best trees to favor because of the value of its wood, even in small trees consisting largely of sapwood. It reproduces well naturally from seeds or sprouts and since the young trees are quite tolerant of shade, they establish themselves readily under larger trees. Many old abandoned fields and pastures are coming up in hickory from nuts scattered by squirrels.

Big Shellbark hickory (*Hicoria laciniosa*), which produces large nuts of excellent quality, and **Mockernut hickory** (*Hicoria alba*), are also valuable species occasionally found throughout southwestern New Jersey. **Bitternut hickory** (*Hicoria minima*) is a tree of less importance which commonly adapts itself to dry, rocky ridges in North Jersey, where it is apt to be scrubby in form.

ASH

White ash (*Fraxinus Americana*) is another of the most important hardwood species. The wood is very strong, tough and flexible (similar to hickory in many respects)—qualities which make it valuable for tool handles, vehicle parts, agricultural implements, paddles and oars, baseball bats, etc. Ash has an important use in the framework, rudders and propellers of airplanes, where wood of great strength, lightness (in comparison to strength), and ability to stand extreme stress is essential. White ash grows vigorously on fairly strong soils too wet for cultivation, although it prefers a moist but well drained site. The sapwood and heartwood are equally valuable, so that trees can be marketed at an early age. Reproduction from seeds or sprouts is usually good, and this species is also recommended for forest planting under suitable conditions. A yield of 10,000 board feet or 20 cords per acre in 25 years is easily possible. An insect known as the "oyster shell scale" frequently attacks ash plantations, and must be watched for.

Black ash (*Fraxinus nigra*) produces a wood somewhat inferior to that of white ash, and is far less abundant in New Jersey. It is most commonly found in wet, swampy situations. **Green ash** (*Fraxinus lanceolata*) is a valuable species which occurs but rarely in this State.

CHESTNUT

Chestnut (*Castanea dentata*) was formerly abundant in New Jersey woodlands, but within the last ten years it has been almost exterminated by the fungus disease known as chestnut blight. Some of the diseased trees are still alive, but practically all New Jersey chestnut will be gone before the year 1925. All standing trees still sound enough to be merchantable should be marketed immediately, or at least cut, piled and seasoned to prevent further decay. The loss of chestnut is particularly deplorable since it was a species well adapted for forestry management because of its extremely rapid growth even on poor soils, its ability to reproduce prolifically from either seeds or sprouts, and the ready utilization of tops and small trees into marketable products. The wood is durable in contact with the soil, and is used extensively for poles, ties, mine timbers, fence posts and rails, while the lumber is used for cheap furniture, planing mill products, turnery, slack-cooperage, wooden-ware, etc. Whether or not chestnut will ever develop immunity from the blight and again become abundant in this State, cannot be foretold at this time.

TULIP POPLAR

Tulip poplar (*Liriodendron tulipifera*), also called Yellow poplar and Whitewood, is our most valuable deciduous soft-wood tree. It tolerates little shade but grows very rapidly on fertile, moist but well-drained soils, and forms tall, straight trees of excellent form for sawlogs. The wood is soft, light, fine grained, and yields a high grade lumber used extensively for planing mill products, musical instruments, cabinets, interior finish of houses and boxes. The manufacturers of veneer baskets use large quantities in this State. Tulip is recommended for planting on soils suitable for its growth where a yield of 30,000 board feet per acre in 50 years can be expected. It is one of the best species to favor in woodland where it occurs naturally, but it should not be confused with the less valuable species of aspen, also called "poplar."

BASSWOOD

Basswood (*Tilia Americana*) is a tree similar to tulip poplar in many respects, though more tolerant of shade and rather less rapid in growth. It is found mixed with other species on fairly strong, moist soils in the hardwood region. Its light, soft but rather tough wood is used largely for trunks, boxes and baskets, as well as for general millwork, furniture, carriages, matches, woodenware, novelties and excelsior. The fibrous inner-bark furnishes bast for mats, cordage, etc. It is a good species to favor where it occurs naturally.

ASPEN

Largetooth aspen (*Populus grandidentata*), also called poplar, is the common species of aspen scattered throughout North Jersey. **Quaking aspen** (*Populus tremuloides*), a northern species, is less abundant in this State. The wood of both species is very light, soft and weak, and is used chiefly for paper pulp and excelsior, and to some extent for box boards and veneer. Aspen grows very rapidly on good, moist but well-drained soil, but is sometimes found on drier soils of poor fertility. It is not abundant in New Jersey, and is not considered a valuable species to favor. It matures and dies at a relatively early age. Aspen should not be confused with tulip poplar, which is a very valuable species.

Cottonwood (*Populus deltoides*), also called Carolina poplar, is a species rarely found naturally in New Jersey, but well adapted to planting on moist, but not swampy, soils. It makes extremely rapid growth, a yield of 25,000 board feet per acre in 30 years being common. Like the aspen it is intolerant of shade, and must not be planted too closely. The wood is soft, light and weak, and is used chiefly for excelsior, paper pulp, boxes and baskets.

ELM

White elm (*Ulmus Americana*) is the largest, most abundant, and most important elm found throughout the hardwood region of New Jersey. **Slippery elm** (*Ulmus fulva*) well known because of its thick, mucilaginous inner bark, is second in importance, although the trees are less abundant and usually smaller in size. **Cork elm** (*Ulmus racemosa*) is another important species, but is not common in New Jersey. The wood of elm is heavy, hard, strong and has in a high degree the ability to withstand shock. It is one of the best woods for bending, and is difficult to split, qualities which make it well suited for slack cooperage, boxes, baskets and crates, vehicle parts, furniture, woodenware and miscellaneous implements. While elm is not one of our most valuable trees, it is of considerable importance, and should be favored especially on wet soils where it occurs naturally. It grows quite rapidly and tolerates some shade.

BEECH

Beech (*Fagus atropunicea*), although nowhere abundant in New Jersey, occurs scattered along the borders of streams and on moist lower slopes in the hardwood region, usually associated with maple, ash, birch, hickory, basswood and hemlock. It is a slow growing species, very tolerant of shade. The heavy, hard, close grained wood is difficult to work and to season, and is not durable. The rather low grade lumber is used chiefly for furniture, shoe lasts, woodenware, and similar purposes where a hard, smooth surface is desired. In the northern states the three common associates—beech, birch and maple—are used extensively for chemical wood, from which wood alcohol, acetate of lime, wood tar and charcoal are the products of a process of distillation. In New Jersey beech is not a valuable species.

MAPLE

Sugar maple (*Acer saccharum*), commonly called hard maple, occurs on moist, fairly strong soils in the northern part of New Jersey, and is our most important maple. Its wood is hard and strong, and is used for furniture, flooring, interior finish, vehicles, tool handles and various implements, woodenware, shoe lasts, musical instruments, as well as for chemical wood where it is abundant. It is more common in the northern states, where "sugar bushes" of that species produce the delicious maple sugar and sirup.

Red maple (*Acer rubrum*) is the most common native species of maple, found on moist soils, or even in swamps, in all parts of New Jersey, but its lighter, weaker wood is somewhat inferior in quality to sugar maple, although it has much the same uses. A still less valuable species is the **Silver maple** (*Acer saccharinum*), which grows rapidly, matures at an early age, and is subject to many forms of decay. It is a common, but unsuitable, tree for street planting. The maples are not included among our most valuable trees.

BIRCH

Like beech and maple the birches are important species in the chemical industry of the northern states, and their hard wood is used for much the same purposes as maple, but in this State they are not regarded as particularly valuable. **Yellow birch** (*Betula lutea*) and **Black** or **Sweet birch** (*Betula lenta*) are the principal lumber species, and are commonly found on moist soils in the northern counties. **Gray birch** (*Betula populifolia*), locally called White birch, closely resembles the true White or paper birch of the North, and like it commonly takes possession of abandoned fields. Its wood is rather soft and weak and has little value in this State except for bean poles and fuel. Another unimportant species is **River** or **Red birch** (*Betula nigra*) which, as its name implies, commonly inhabits the banks of streams.

GUM

Red gum (*Liquidamber stryaciflua*), also called Sweet gum or Bilsted, is a tree of considerable importance in the hardwood region of Central and South Jersey, where it commonly occurs on wet, or even swampy soils. Its medium hard, fairly strong wood is used chiefly for boxes, crates and baskets, slack cooperage, furniture, woodenware and novelties. It is not an especially valuable species, but is of considerable local importance in regions where it is common. It is well to favor this tree on wet soils.

Black gum (*Nyssa sylvatica*), commonly known as Pepperidge or Sour gum, is a swamp tree neither abundant nor valuable. The wood is very difficult to split, and when steamed is sometimes used for veneer boxes or baskets. It is also used for "rolls" or "rollers" in factories.

LOCUST

Black locust (*Robinia psuedacacia*), or Yellow locust as it is sometimes called, is not native to New Jersey, but has been planted here in groves or along fences rows and highways for many years. Its very heavy, very hard, very strong, very durable wood is excellent for fence posts, railroad ties, insulator pins, tree-nails, and other uses where extreme strength and durability are desired. It grows very rapidly in early life on strong, well drained soils, reaching a size suitable for fence posts in from 10 to 20 years, and for railroad ties in 25 to 35 years. It may become one of our most valuable hardwoods for planting although it is susceptible to damage by the locust borer, an insect which sometimes destroys entire groves. Recent investigations indicate that individual trees or open stands are much more likely to be damaged than close, dense stands, as the insects seem to avoid shade. If this proves to be true, the pests can be readily controlled by planting close or in mixture with other species.

Honey locust (*Gleditsia triacanthos*) is a less common and less important species that has been planted to some extent for shade in this State. Its characteristics and uses are similar to those of Black locust.

WALNUT

Black walnut (*Juglans nigra*) is one of the highest priced woods in this country, and has been so extensively used for cabinet work, furniture, and gunstocks that it has become very scarce. In New Jersey it is only found along fence rows, highways or in groves where it has been planted. Walnut thrives only on fertile soils that could usually support agricultural crops, and therefore is not recommended for forest planting. Moreover, since only the heartwood is of great value, a tree must reach considerable size before it can be marketed to the best advantage. Where shade and nuts are wanted, as along lanes and highways, or around farm buildings, black walnut is a good tree to plant.

Several hybrid varieties of walnut have been advocated for planting recently, but the optimistic claims made in their behalf as to rate of growth and the profits to be derived have been generally found to be exaggerated, except for unusual conditions of climate and soil fertility, where agricultural crops would probably prove even more profitable.

Butternut (*Juglans cinerea*) is less common and less popular than walnut, but produces a handsome, though inferior, wood. As a forest tree it is of little importance.

OTHER HARDWOODS

Black cherry (*Prunus serotina*) is a very valuable furniture and cabinet wood, but is rarely found in New Jersey. **Fire cherry** and **Choke cherry** are unimportant weed trees, never growing very large, and practically good for nothing but firewood.

Sycamore (*Platanus occidentalis*), usually found bordering streams and swamps, is one of the largest hardwood trees in the United States in the diameter of trunk, although others surpass it in height. In the Ohio Valley trees 14 feet in diameter have been found. It is not an important species in New Jersey. The wood is tough and difficult to split, and is used for boxes, baskets and butcher blocks

While not a forest tree, **apple** wood from orchards which have outlived their usefulness is used in the manufacture of tobacco pipes and fine saw and tool handles. The wood is hard and dense. **Sassafras** (*Sassafras sassafras*), usually a shrub, but sometimes of tree size, is regarded as a weed tree although it makes fair fence posts, since its rather soft wood is quite durable. **Dogwood** (*Cornus florida*), well known because of its beautiful flowers in the spring, produces a small scrubby tree, occasionally large enough to be utilized. The wood is very hard, very heavy and close-fibred and is used for shuttles and wooden bearings. **Persimmon** (*Diosperus Virginiana*) is a rather rare species occasionally found in South Jersey, which makes good shuttles and wooden bearings. **Holly** (*Ilex opaca*), famous for its leaves and

berries as Christmas decorations, is a small tree commonly found mixed in with South Jersey hardwoods. Its white wood is used chiefly as inlay in the manufacture of musical instruments, where it affords fine contrast with walnut, mahogany, cherry, and other dark woods. **Hornbeam** (*Ostrya Virginiana*) and **Blue Beech** (*Carpinus Caroliniana*), both known as ironwood, form small trees of very tough, hard wood, occasionally used for tool handles, woodenware and fuel. **Witch Hazel** (*Hamamelis Virginiana*) is a shrub that occasionally reaches small tree size. The wood is of no commercial value, but an extract from the bark is used extensively in medicine.

These species are all regarded as weed trees and should be discouraged in woodlands in favor of more valuable species. At the same time, where they do occur they should be used and marketed to the best advantage. Many an owner has found an unexpected profit by hunting up a market among the specialized industries that use these species.

CONIFERS OR EVERGREEN SPECIES

PINE

Pitch pine (*Pinus rigida*) is the common pine of the South Jersey sands, but is also found scattered along the ridges of North Jersey. The wood is of medium weight and hardness, rather coarse grained and decidedly resinous. While it does not make high grade lumber, it makes good common lumber. Large quantities are used locally for box boards, construction lumber, piling and fuel. This species is especially suited to the box board industry, which makes a permanent demand for a relatively cheap lumber.

Pitch pine is by no means the valueless tree that many persons imagine; repeated fires are the cause of its common stunted and scrubby form. It makes fair growth on soils too poor for most other species, reproduces prolifically from natural seeding, and resists fire damage better than any other tree. For these reasons it is one of the best species for the South Jersey sands. Like all the pines, it tolerates little shade. Pitch pine is one of the few conifers to reproduce from sprouts, although the sprouts are scrubby and never make sizable trees.

Shortleaf pine (*Pinus echinata*) or "two-needle" pine, as it is called locally, is less abundant than pitch pine in Central and South Jersey, where it usually occurs mixed with the latter species and oak on the better soils. Although similar to Pitch pine in most respects, the form of the tree is usually better and the lumber is of higher quality. Shortleaf pine is well adapted to the South Jersey sands and is recommended for planting in this region.

Loblolly pine (*Pinus taeda*) is a native of the Southern states, where it grows with marvelous rapidity. It is a tree similar in many respects to pitch pine, although its lumber is of higher quailty. Recent experimental plantations indicate that it can be grown successfully in South Jersey, but that in exposed situations north of Trenton it succumbs to drying and freezing winter winds. For the present, until more is learned of its adaptability to New Jersey conditions, it is recommended only for experimental planting.

Scrub pine (*Pinus Virginiana*) is a relatively unimportant species found scattered with the other South Jersey pines, chiefly along the western edge of the pine belt. As the name implies, it is usually scrubby in form. Where trees of suitable size are found, it is marketed and used together with Pitch pine.

White pine (*Pinus strobus*) is found in limited quantities scattered throughout North Jersey, although here, as elsewhere, the original supply has been greatly depleted because of the value of its soft, fine-grained wood for building lumber, planing mill products, boxes, crates, etc. This species grows very rapidly on fertile, well-drained soils, or even on poorer soils if not too wet, and is one of the best to favor where it now occurs. Extensive planting is not advised at present because of the danger of the blister rust disease, now so destructive in New England. Another common enemy is the White Pine weevil, an insect which deforms young

trees by killing the terminal shoot. Were it not for these pests, white pine would be one of our most promising trees for planting, since it is adapted to South Jersey sands as well as to North Jersey hillsides. A yield of 30,000 board feet per acre in 50 years is not excessive.

Red or Norway pine (*Pinus resinosa*), the common pine of the Lake states, is not native to New Jersey, but it is highly recommended for planting as a substitute for white pine, for it is similar to this species in many respects and apparently has no dangerous enemies. The wood is a little heavier than white pine, but also stronger, and is used for similar purposes. Red pine grows almost as rapidly as white pine and its soil requirements are similar.

Scotch pine (*Pinus sylvestris*) is the common pine of Europe. It thrives on good soils, and makes fair growth on even the poorest and driest gravelly slopes or sands. It is especially vigorous when young. The wood produces lumber almost equal to red pine in quality. A yield of 25,000 board feet per acre in 50 years should be obtained from a plantation established under fair conditions.

Austrian pine (*Pinus austriaca*) is somewhat similar to Scotch pine in most respects, but is not so popular with planters in this country.

SPRUCE

Black spruce (*Picea mariana*) is the only species of spruce native to New Jersey, and is limited in range to a few swamps of high elevation in the northern counties. It is of little importance in this State since practically all of larger trees have been cut for lumber. Within its limited range natural reproduction should be favored.

Norway spruce (*Picea excelsa*), the common spruce of Europe, is a tree of considerable value because its wood is sought for paper pulp as well as for lumber, and because, by reason of its tolerance of shade, it is able to grow in close stands. For the best growth it requires fairly strong soil, and thrives on ground much more moist than is acceptable to any of the pines, although it will not grow well where the soil is constantly wet. For planting this species seems to be preferable to any of our native American spruces, such as white or red spruce, and will yield about 30,000 board feet per acre in 60 years. It is recommended for planting in North Jersey, and experiments indicate that it is fairly well suited to the better South Jersey sands. It is being extensively planted for Christmas trees. Two year seedlings of Norway spruce are commonly quite small, so that it is sometimes more desirable to plant three year old transplants.

FIR

Balsam fir (*Abies balsamea*), a native of the northern states, does not grow naturally in New Jersey, but it is hoped that experimental plantings will prove it to be a good species for planting in the northern counties because of its adaptability to moist land, its high degree of tolerance to shade, and the production of a wood that is suitable for the same uses as spruce. In many situations the plantations may be made with a view to marketing Christmas trees, for which either species is suitable. A mixture of balsam and Norway spruce, or balsam and red or white pine, the balsam to be removed for Christmas trees at from 6 to 12 years, leaving the spruce or pine to grow to timber size, is often advisable.

Douglas fir (*Pseudotsuga taxifolia*), the most important construction timber of the Pacific northwest, is not a true fir, but a species resembling both fir and hemlock in some respects. The quality of its durable lumber is far superior to either, comparing favorably with that of red or shortleaf pine. Observations of New Jersey plantations indicate that Douglas fir may be adapted to planting on soils that are not too poor or excessively wet, and that its growth is equal to that of Norway spruce, although the stands are not quite so dense. It makes attractive Christmas trees.

CEDAR

Southern White Cedar (*Chamaecyparis thyoides*) is the common cedar found in dense, pure stands in South Jersey swamps. Its soft, light but very durable lumber is extensively used for boat boards, siding, boxes, shingles and lath, and there is a constant demand for round timber for poles, posts, grape-stakes, bean poles, and rustic furniture. After lumbering, many cedar swamps in this region have been converted into cranberry bogs. While cedar usually grows slowly, because of the natural dense stands, it becomes valuable at an early age since small trees can be profitably marketed. Natural reproduction is usually abundant following lumbering, and swamps not needed for other purposes should be kept in cedar.

Northern White cedar, or Arborvitae (*Thuja occidentalis*) is not native to New Jersey. Its general characteristics, habits of growth, quality of wood, and uses are similar to Southern White cedar, and it should be considered for planting in North Jersey swamps where timber growth is now lacking.

Juniper or Red cedar (*Juniperus Virginiana*) is found scattered all over New Jersey, principally on old abandoned fields and along fence rows where seeds have been scattered by birds. Unlike white cedar, it is intolerant of shade, does not form dense stands, and avoids wet soils. It is common on dry sands and gravelly ridges where other more tolerant species do not crowd it out. Its very durable wood makes it a favorite for fence posts, but in this State its growth is so slow, and the form of the tree so scrubby, that it is not recommended for planting, although it should be favored where found naturally. In the southern states, where it makes better growth, it is used extensively for pencils, cedar chests, etc.

LARCH

Eastern Larch or Tamarack (*Larix Americana*). In a few scattered swamps in the northern part of New Jersey, tamarack reaches the southern limit of its natural range. Its wood is durable in contact with the soil, and is suitable for railroad ties and fence posts, as well as for lumber. It is too scarce in New Jersey to be considered an important species, but natural reproduction should be favored where found.

European Larch (*Larix europaea*). This European species is especially valuable on account of the durability of its wood, and may be planted where the extinction of chestnut is likely to create a demand for posts and poles. Unlike the eastern American species, it requires well-drained as well as fairly strong soil. It is usually advisable to plant it in mixture with some other species, allowances being made for its intolerance of much shade. European larch seedlings open their buds so early in the spring that fall planting must ordinarily be resorted to in this climate.

HEMLOCK

Hemlock (*Tsuga canadensis*) is found scattered throughout North Jersey in cool, moist situations, on rocky slopes and bordering streams and swamps, but is nowhere abundant. Hemlock is very tolerant of shade and persists for years growing slowly under other trees. It produces a rather coarse, weak, low grade lumber, which is not at all durable. It cannot be considered a valuable species, and is not recommended for planting except as an ornamental tree. In the past great quantities of hemlock bark have been used for tanning leather.

MECHANICAL PROPERTIES OF WOOD

Great variation of mechanical properties is found in woods of different species, and there is often considerable variation in wood of the same species, according to the age and condition of the tree, the rate of growth, the region of growth, the soil and the moisture conditions, the part of the tree from which the wood was taken, the treatment after cutting, the moisture content of the wood, or any abnormal conditions. The table on pages 72 and 73, compiled from records and tests of the U. S. Forest Service and other sources, gives a relative comparison of the mechanical properties of the more important and more common native species and those recommended for planting.

Weight.—The weight of wood varies greatly in different species, and to a less extent in different individuals of the same species or even in different portions of the same tree. The table of relative weights of wood on pages 72 and 73 is based upon similar specimens of air-dry wood, that is, with a moisture content of about 12 per cent. Green living wood usually weighs from 20 per cent to 50 per cent more than dry wood because of its water content. When green, the *sapwood,* or outer living wood of the tree, is usually heavier than the inner *heartwood;* when dry, the heartwood is generally heavier. The specific gravity of wood substance is about 1.6; hence the reason any wood floats in water is because of the buoyance of the air imprisoned in its cells and spaces. When this air is displaced by water the wood becomes "water-logged" and sinks. Woods composed of thick-walled fibres are dense and heavy. Other things being equal, the weight of wood is a fair criterion of its hardness and strength.

Hickory is one of the heaviest woods. A cubic foot of green wood weighs about 64 pounds, and about 52 pounds when air-dry. Black walnut is moderately heavy, a cubic foot weighing about 56 pounds when green, and 37 pounds when dry. White cedar is one of the very light woods, a cubic foot of green wood weighing 28 pounds, and dry wood 22 pounds.

A cord of heavy wood, such as oak or hickory, weighs about 4000 pounds when air-seasoned; a cord of medium weight woods, such as pitch pine, red maple or chestnut, weighs about 3,000 pounds, air dried.

The following are the accepted dry weights of 1,000 board feet of rough lumber in boards 1 inch thick.

Hickory	5,000 pounds	Shortleaf Pine	3,400 pounds
Oak	3,900 pounds	Chestnut	2,800 pounds
Ash	3,500 pounds	White Pine	2,400 pounds

Hardness is a property which needs little explanation. Other things being equal, hardness is increased by seasoning, so that dry wood is usually harder than green wood. Weight of wood is ordinarily a fair test of its hardness, since heavy woods are usually hard, and light woods soft. The standard test for hardness is to measure the load required to embed a half-inch metal ball one half its diameter in the wood. End hardness of a board or timber is usually greater than side hardness.

Stiffness, or rigidity, is the ability of wood to resist bending. Stiffness, to a certain degree, is a measure of strength, although some woods like pitch pine are stiff up to a certain limit, but break readily if the load is increased, while other woods like elm bend readily but resist breaking. Dry, seasoned wood is usually considerably stiffer than green wood.

Strength may be used to describe several qualities of wood, which should not be confused. In the following table "Strength as a Beam" means the load a timber can support without breaking. Dry wood is usually stronger in this respect than green wood. Heavy wood is commonly but not always stronger than light wood. For instance, white ash is a lighter but stronger than black oak. Spruce is very light, but quite strong in comparison to its weight. A 12-inch beam of spruce would not support as heavy a load as a 12-inch beam of black oak would, but a 1,000 pound beam of spruce would be far stronger than an oak beam of equal weight.

Resistance to Shock.— The ability to absorb sudden shock without injury depends largely upon the quality of toughness. Some light woods like willow, gum and basswood are not strong, but withstand shock very well, although the harder and heavier woods are usually stronger in this respect.

Durability means the ability to resist decay under unfavorable conditions, as a post, railroad tie or pole, in contact with the ground. Dry wood does not decay. Hence wood under cover, or protected by paint or preservative, may resist decay indefinitely, whereas an unprotected post of the same material would soon rot.

Seasoned wood is much more durable than green wood. Heartwood is more durable than sapwood. Weight, hardness or strength are no indication of durability. Hickory is very heavy, very hard, and very strong, but decays readily; locust is heavy, hard and strong, and very durable; cedar is very light, soft and weak, and very durable; spruce is light, soft and weak and not at all durable.

WOOD PRODUCTS AND USES

Lumber.—Practically all species of trees that grow to saw-log size are used at times for lumber, and the lumber is put to countless uses, the most important of which have already been discussed in the description of the various tree species, pages 61 to 68. The qualities and characteristics of each kind of wood are indicated by the table on pages 72-73. Therefore it is not necessary to repeat this information here. It should be remembered, however, that lumber is usually the product of the highest quality, and trees of saw-log size or form can often be most profitably marketed as lumber, or to industries which make lumber from the logs.

Poles.—Many thousands of poles are used annually in New Jersey for the construction of telegraph, telephone, trolley, electric and power lines. Species most suitable for poles must produce a wood that is durable in the ground, not too heavy in weight on account of excessive transportation costs, yet strong enough to resist the stress and strains imposed upon it. Moreover, poles should be fairly cylindrical, straight and gradually tapering. The timber must be accessible and available in such quantities that it can be placed on the market at a reasonably low price.

Chestnut and southern white cedar are the two native species commonly used for poles in this State. Both species have all the requisities for a good pole, being very durable, of light weight, and fairly abundant. In the near future our supply of pole material of chestnut and cedar will be practically exhausted, and then we must either use other species or import poles at a great cost from other states. White oak makes fairly durable poles, but is heavy to handle or ship. As more desirable species become exhausted pine will probably become an important pole wood when treated to prevent decay.

Poles vary from 20 to 75 feet in length, but those most commonly used are from 25 to 40 feet long with a minimum top diameter of 5 or 6 inches. Poles are sold by the piece, prices varying according to size, length and species.

Furnace or Smelting Poles are used in considerable quantity by the smelters along the coast in the vicinity of Raritan Bay. Smelting poles are green, unseasoned hardwood poles usually from 20 to 40 feet long, with butt diameters ranging from 6 to 20 inches, and minimum top diameters of from 3 to 6 inches. They are usually purchased by weight at so much per ton (shipping weight), although cord measure is occasionally used.

Piling.—Large quantities of piling are used in the construction of docks and wharves, building foundations, and bridges. Piles are usually classified as permanent or temporary, according to the intended use. White oak and chestnut are sold for permanent piling, while almost any species that can be driven with a pile driver can be used for temporary piling. The species most favored, however, are red oak, pin oak, black oak, pitch and shortleaf pine, beech, maple, hickory, ash and elm. Piles vary from 20 to 75 feet in length, with top diameters of from 6 to 10 inches and butt diameter of from 12 to 20 inches. Piling is usually sold by the linear foot, prices varying with the size, length and species.

Ties.—With the rapid expansion in American railway development there has arisen a great demand for ties. The large number used can be comprehended from the fact that standard railway construction uses 2640 ties per mile of single track, and the average life of untreated ties is not over 5 years.

Timber suitable for the best ties must be durable, strong enough to hold up under the load imposed, and abundant enough to supply the enormous demands. The strong, durable wood of black locust makes an ideal tie but this species is not abundant enough to be an important source. Cherry and walnut also make excellent ties but are too scarce and too valuable for other purposes to be extensively used. The white oaks, including both white oak and chestnut oak, form the bulk of the highest grade native ties. Chestnut is also extensively used. These species cannot fill the demand, however, so that other species less durable are being used after treating with preservatives. Red and black oak, yellow pine, birch, beech, maple, elm and gum, species which would ordinarily decay in less than 5 years, will last several times as long after the preservative treatment.

Standard railroad ties are usually 8½ feet long, 6 to 8 inches thick, and 7 to 9 inches wide. They are either sawed at mills or hewed in the woods. Trolley ties are usually smaller than standard ties and large quantities of "seconds" of railroad ties are used for trolley lines.

Fence posts are usually cut 7 feet in length, although they may be longer or shorter for special use. Round posts are from 4 to 6 inches in diameter at the top end, while split posts are of similar volume. The principal qualifications of a good fence post are resistance to decay, ability to take and hold a nail well, and cheapness. Black locust, red cedar, chestnut, white cedar and white oak are the best post trees, in the order named. Almost any species makes good posts if the butts are treated with preservatives.

Chestnut and cedar rail fences are fast disappearing from use with the growing scarcity of available wood. A well made rail fence will last longer than a wire fence, is better for some purposes, and where suitable timber is available, may be cheaper.

Mine Timbers.—Large quantities of New Jersey timber are used in the mines of North Jersey and Pennsylvania, in underground work for mine ties, rails, props, caps, and collars. Many species are used, although those that are strongest and most durable are preferred, such as oak and chestnut. Prop timber is usually from 10 to 30 feet long with a top diameter of from 6 to 10 inches. Collar timber is ordinarily from 10 to 30 feet long (averaging 15 feet) with top diameters from 10 to 14 inches. Mine rails are squared 3 by 5 inches and from 12 to 16 feet long. Oak, beech, birch and maple are preferred. Mine ties, of oak or chestnut, are usually 5 to 7 feet long, 4 to 5 inches thick and 4 to 5 inches wide, hewed or sawed on two sides.

Cordwood.—The use of wood for fuel has been greatly stimulated during the period of the World War and the years immediately following, by the scarcity and high price of coal. In 1920 more than 33,000 farms in New Jersey were estimated to have used on the average of 8 cords per farm, or a total of 264,000 cords. Many thousand cords more were consumed by manufacturing industries and by residents of communities which found wood easier to get and cheaper to use than coal, at the prevailing prices. The coal miners' strike of 1922 further increased cordwood consumption.

The use of cordwood should be encouraged, for there is an abundance of mataerial in our forests fit only for fuel, which will be wasted unless used in this way. When wood can be obtained from home woodlands, or where it can be purchased close at hand at reasonable prices, it is far cheaper than coal. Many farmers are using coal costing at the present time (1922) from $12 to $15 per ton, not including the hauling, when they could most profitably utilize their spare time by cutting and hauling cordwood from their woods. Allowing current wages for this labor, their wood would cost them from $3 to $5 per cord. Two pounds of wood have the heating value of one pound of hard coal, and a cord of heavy wood weighs about two tons; therefore a cord of such wood (oak, hickory, beech, birch, sugar maple)

MECHANICAL PROPERTIES OF WOODS

Species Native to New Jersey or Recommended for Planting

Hardwood Species	Weight (Air-Dry)	Hardness	Stiffness	Strength as a Beam	Resistance to Shock	Resistance to Decay
Ash, black	Moderately heavy	Moderately hard	Moderately stiff	Moderately strong	Good	Not durable
Ash, white	heavy	hard	stiff	Very strong	Very good	Not durable
Aspen, large-tooth	light	soft	Moderately stiff	weak	Moderately poor	Not durable
Basswood	light	soft	Moderately limber	weak	Moderately good	Not durable
Beech	heavy	hard	Moderately stiff	strong	good	Not durable
Birch, black	heavy	hard	Very stiff	strong	good	Not durable
Birch, gray	Moderately heavy	Moderately hard	Moderately stiff	Moderately strong	good	Not durable
Birch, yellow	heavy	hard	Very stiff	strong	Very good	Not durable
Butternut	light	Moderately soft	Moderately limber	weak	Moderately good	Slightly durable
Cherry, black	Moderately heavy	Moderately hard	Moderately stiff	strong	good	Moderately durable
Chestnut	Moderately light	Moderately soft	Moderately limber	Moderately weak	Moderately poor	durable
Cottonwood	light	soft	Moderately limber	Moderately weak	Moderately poor	Not durable
Dogwood, flowering	Very heavy	Very hard	Moderately stiff	Moderately strong	Very good	
Elm, white	Moderately heavy	Moderately hard	Moderately stiff	Moderately strong	Very good	Slightly durable
Gum, black	Moderately heavy	Moderately hard	Moderately limber	Moderately weak	Moderately good	Not durable
Gum, red	Moderately heavy	Moderately hard	Moderately stiff	Moderately strong	Moderately good	Slightly durable
Hickory, shagbark	Very heavy	Very hard	Very stiff	Very strong	Very good	Not durable
Holly	heavy	hard	Moderately limber	Moderately weak	good	
Ironwood	Very heavy	Very hard	stiff	strong	Very good	
Locust, black	Very heavy	Very hard	Very stiff	Very strong	Very good	Very durable
Locust, honey	heavy	hard	stiff	strong	good	Moderately durable
Maple, red	Moderately heavy	Moderately hard	stiff	Moderately strong	Moderately good	Not durable
Maple, silver	Moderately heavy	Moderately hard	Moderately limber	Moderately weak	Moderately good	Not durable
Maple, sugar	heavy	hard	stiff	strong	good	Not durable
Oak, chestnut	heavy	hard	stiff	strong	Moderately good	Moderately durable
Oak, black	heavy	hard	stiff	Moderately strong	good	Slightly durable
Oak, red	heavy	hard	stiff	Moderately strong	good	Slightly durable
Oak, white	heavy	hard	stiff	strong	good	Moderately durable
Persimmon	Very heavy	Very hard	Very stiff	Very strong	good	

MECHANICAL PROPERTIES OF WOODS

Species Native to New Jersey or Recommended for Planting

Hardwood Species	Weight (Air-Dry)	Hardness	Stiffness	Strength as a Beam	Resistance to Shock	Resistance to Decay
Poplar, tulip	light	soft	Moderately stiff	Moderately weak	poor	Not durable
Sassafras	Moderately light	Moderately soft	Moderately limber	Moderately weak	Moderately good	Moderately durable
Sycamore	Moderately heavy	Moderately hard	Moderately stiff	Moderately weak	Moderately good	Not durable
Walnut, black	Moderately heavy	Moderately hard	stiff	strong	good	durable
Willow, black	light	soft	Very limber	Very weak	Moderately good	Not durable
Coniferous Species						
Cedar, red	Moderately light	Moderately soft	Moderately limber	weak	poor	Very durable
Cedar, white	Very light	Very soft	Very limber	Very weak	Very poor	durable
Fir, balsam	Very light	soft	Moderately limber	weak	Very poor	Not duraole
Fir, Douglas	Moderately heavy	Moderately hard	stiff	strong	Moderately good	Moderately durable
Hemlock	light	soft	Moderately limber	weak	Moderately poor	Not durable
Larch, (tamarack)	Moderately heavy	Moderately hard	Moderately stiff	Moderately strong	Moderately good	Moderately durable
Larch, European	Moderately heavy	Moderately hard	Moderately stiff	Moderately strong	Moderately good	Moderately durable
Pine, loblolly	Moderately heavy	Moderately hard	stiff	strong	Moderately good	Not durable
Pine, pitch	Moderately heavy	Moderately hard	Moderately stiff	Moderately weak	Moderately good	Slightly durable
Pine, red	Moderately light	Moderately soft	stiff	Moderately strong	Moderately good	Slightly durable
Pine, scrub	Moderately heavy	Moderately hard	Moderately stiff	Moderately weak	Moderately good	Not durable
Pine, Scotch	Moderately heavy	Moderately hard	Moderately stiff	Moderately strong	Moderately good	Slightly durable
Pine, shortleaf	Moderately heavy	Moderately hard	stiff	Moderately strong	Moderately good	Slightly durable
Pine, white	light	soft	Moderately limber	Moderately weak	poor	Slightly durable
Spruce, Norway	light	soft	Moderately stiff	Moderately weak	poor	Not durable

has the heating value of a ton of coal. A cord of lighter wood, such as chestnut, pine or red maple, equals two-thirds of a ton of coal in heating value. To be as cheap as wood at $6 per cord, coal must sell for from $6 to $9 per ton, delivered. Wood is frequently more convenient to use than coal, especially for cooking fires during the summer months. Moreover, the ashes of a cord of wood contain a considerable quantity of valuable potash fertilizer. A cord of wood occupies 128 cubic feet of space, equal to a pile of 4-foot wood 4 feet high and 8 feet long.

Baskets.—The basket industry is important in New Jersey. A number of basket factories in Central and South Jersey use large quantities of tulip poplar, red gum, basswood, maple, birch and elm logs in the manufacture of veneered baskets; fruit, berry and vegetable containers. The logs are cut into bolts of the desired length, subjected to a hot water or steam bath for a time to soften the wood, and then cut into thin sheets of veneer, from which basket slates are cut, by revolving the bolt against the cutting edge of the veneer lathe.

Baskets made of split slats or staves from white oak or hickory bolts are commonly used for oyster baskets, market baskets, and laundry baskets. Most of the baskets of this sort are made by hand, in small sized operations.

Boxes.—The manufacture of box-boards is important from the standpoint of forestry, since relatively low grade lumber sawed from rapidly grown young trees can be profitably used for this product. Wood suitable for boxes should be light in weight and strong enough to stand up under use. The grade and quality of the lumber desired of course depends upon the intended use of the boxes. White pine, spruce and Southern yellow pine are imported into New Jersey for the best box boards. In South Jersey large quantities of pitch pine, shortleaf pine and white cedar are used for cranberry crates, fruit and vegetable boxes. Other native species suitable for boxes for certain purposes are red gum, hemlock, tulip poplar, basswood, chestnut, maple, sycamore and birch.

Cooperage is the art of making vessels or containers of wood bound together by hoops. *Tight Cooperage* is distinguished from *Slack Cooperage* in its ability to contain liquids. Cooperage uses three forms of wood:—staves, heading, and hoops.

Slack Cooperage products consist of barrels for shipping cement, flour, sugar, fruit, vegetables, and similar products; also tubs, buckets, kegs, firkins, etc. Almost any wood can be used for heading and staves, although those that are abundant and fairly cheap, light yet strong, and which retain their form when bent, are desired. Large quantities of oak were formerly used, but the high value of oak for other purposes has caused a change to less expensive woods. Red gum, elm, maple, beech and chestnut are our most common stave woods. Elm and hickory are commonly used for hoops, although metal hoops are gradually replacing those of wood because of their cheapness.

Tight Cooperage requires a more carefully manufactured article, because it must hold liquids. A wood which is hard and strong, of impermeable wood structure, which will not discolor or taint the contents of the barrel or container, is usually desired. White oak is considered the best wood for tight cooperage. Red oak is more susceptible to leakage owing to its open pores, but is also used, along with red gum, ash, beech, birch and maple.

Wood Pulp and Paper.—The pulp and paper industry is not important in New Jersey because there are very limited supplies of the best pulp woods. A good pulp wood should have a long, strong fibre and should be soft, light colored and free from such constituents as resin, gum, tannin, etc. It must also be available in sufficient quantities and fairly economical in price. Some woods are admirably adapted to the manufacture of paper, yet are eliminated because they are not sufficiently available or are in greater demand for other purposes. Spruce is the best and most commonly used pulpwood, followed by fir, hemlock and aspen. None of these species are abundant in New Jersey, nor are they ever likely to be.

In late years the consumption of paper has increased so greatly that a shortage of the accessible pulpwood supply has caused manufacturers to develop new processes whereby almost any species of wood can be used, especially for lower grades

of paper. Pine, maple, beech and chestnut, as well as other species, are now being used in considerable quantities and their use will undoubtedly increase. Small quantities of pitch pine from South Jersey are being used for paper. In the future sawmill and logging waste may form a considerable portion of the pulpwood supply.

Excelsior consists of thin, curled strands or shreds of wood made by rapidly moving knives or fine steel teeth against a wood bolt. It is used extensively for upholstery, mattresses, and for packing miscellaneous articles which are susceptible to breakage. A wood suitable for excelsior should be soft but with a rather tough fiber, light colored and straight grained. It should preferably be free from gum or resin that are likely to discolor or taint any material with which it comes in contact. Basswood makes the best excelsior, but it is not extensively used because of the limited supply and the demand for it for other purposes. Cottonwood and aspen are most commonly used. Lower grades of excelsior are made from pine, tulip poplar, red gum, soft maple, spruce, chestnut, hemlock, and white cedar.

Charcoal is charred wood as a result of partial or incomplete combustion. Years ago this industry was important in New Jersey and large quantities of hardwoods and pine were made into charcoal by the open-pit method, which consisted of slowly burning a compact conical pile of wood, covered over with grass, leaves, moss and earth, allowing just enough draft through prepared flues to cause only partial combustion. This crude method was very wasteful, because the volatile products which pass off in the process of combustion were not recovered. Most charcoal is now made as a by-product in the distillation of wood in closed retorts, which process also obtains wood alcohol, acetic acid and wood tar from hardwoods, and turpentine, wood oils and tar from resinous woods such as pine.

Charcoal was formerly used extensively in the manufacture of iron, but with improved methods and the greater use of coke, the demand for charcoal has fallen off. It is also used in the manufacture of gunpowder and explosives, as a filtrant, for medicinal purposes, as a reducing agent in metallurgical operations, and for fuel.

Heavy dense woods, such as hickory, oak, maple, beech and birch are regarded as best for high grade charcoal, although other woods are also used.

Hardwood Distillation.—An industry most important in the northern States is the distillation of hardwoods in closed retorts, where by the application of great heat, gases and oils are driven from the wood and converted into wood alcohol, acetic acid and wood tar,—leaving the wood itself in the form of charcoal. This industry has almost entirely replaced the old open-pit method of burning charcoal.

The best "chemical woods", as they are called, are birch, beech and maple, although oak, hickory and ash are also used to a less extent. Soft woods, or those containing excessive gum, resin or tannin cannot be used. The chemical industry has not been important in New Jersey, but may become so as the supply of accessible woods in the north becomes exhausted.

Naval Stores.—Resinous woods, when distilled in closed retorts in much the same way as "chemical" hardwoods, yield the so-called naval stores, turpentine, wood oils and tar, as well as charcoal. Longleaf pine of the Southern States is the best wood for this kind of distillation, and practically the only one used at present. Our native pines—pitch pine and shortleaf pine—are less adapted to distillation, but may be used in the future as it becomes impossible for the Southern pines, the supply of which is rapidly becoming exhausted, to fill the demand for naval stores. Another form of distillation of resinous woods by the use of steam yields the naval stores, but leaves the wood in a condition suitable for paper pulp.

The distillation of resinous woods is not the most important source of naval stores, since most of the turpentine, resin and tar is now obtained from the pitch of longleaf pine, collected from cuts made at the base of living trees.

Tanning.—Many plants of the vegetable kingdom contain an astringent substance known as tannin, which is used in tanning animal hides and skins. Practically all of the commercial tannin is derived from a variety of barks, woods, leaves, or fruits of a comparatively few species.

For a long time hemlock bark was the principal source of tannin in this country, but the bulk of the eastern supply has now been exhausted, and other species are being used extensively. Since the discovery of a method whereby the tannin content of chestnut wood could be successfully extracted, more than two-thirds of all the tannic acid products made in the United States are now derived from this source. The extract of tannin from chestnut is largely confined to Virginia and North Carolina, since Southern chestnut contains more tannin than the same species grown in the North. The bark of chestnut oak and California tanbark oak is also rich in tannin, and is being used more extensively. Other materials less used are the barks of other oaks, especially black oak, and leaves of a Southern sumach.

Imported materials also form an important source of tannin, the most important of which are Quebracko wood from South America, Mangrove bark from the tropics of Africa and Central America, Myrobalan nuts from India, and sumach from the Mediterranean region.

Dye Woods.—At the present time aniline dyes compose a large percentage of all the dyeing materials used, although for certain purposes a few dye woods are held in high esteem in the textile and leather trades. Most of the natural dyes are now produced from imported woods from Central and South America and the West Indies. Of the native species used, Osage orange is the most important. This species is most abundant in the lower Mississippi Valley but is occasionally planted as hedges in New Jersey. Other native materials used to a very limited extent are black walnut and butternut, sumach, alder, red gum, and dogwood. New Jersey probably will never be an important source of dye woods, but occasionally some of our forest by-products may be used in this industry.

Wood Preservation.—Decay of wood is caused by various forms of bacteria and fungus growth which thrive only in the presence of moisture, air and warmth. Wood inside buildings does not rot because it is kept dry; wood under water resists decay, because of the absence of air and warmth; neither does wood decay rapidly in cold climates nor in winter. Wood exposed to the weather is ordinarily preserved by painting, which excludes moisture. Wood in contact with the ground, such as poles, ties and posts, decays most rapidly, because it is usually moist, especially where it touches the earth. Some woods are naturally more durable than others, due to their structure, or to some chemical substance within the wood. (See table, pages 72-73.)

With the decreasing supply and increasing cost of timber, electric companies, railroads and other users of poles and ties find it a great saving to treat these products with a preservative, which doubles or trebles their life and saves the cost of several replacements. Creosote is one of the best preservatives known, because it effectively prevents and kills the growth of fungi, penetrates most woods readily, remains in the wood well to insure adequate protection, is safe to handle (although it burns readily and has a rather objectionable odor), and is reasonable in cost. Most effective penetration is obtained in commercial treating plants where hot creosote is forced into the wood under pressure. Other preservatives less extensively used are zinc chloride, tar and crude oil.

With the death of chestnut, the growing scarcity of white and red cedar, and the high value of white oak for other products, farmers and other users of fence posts are finding it economical and desirable to use cheaper, more abundant, and less durable woods. At a cost of a few cents per post for creosoting, red oak, pine, similar woods can be made to last many years. Some dense woods, such as white oak and chestnut oak, resist the penetration of creosote.

An excellent home treating plant can be constructed at the cost of a few dollars, with which a farmer can preserve his own posts and other timbers easily, as well as those of his neighbors. An iron tank, about 3 feet in diameter and 4 feet high, is erected over a brick or stone fireplace, and enough creosote is poured in to immerse the butts of the posts to a point 6 inches above the ground line when set. The posts should be thoroughly air dried with the bark removed, before treatment. The creosote is then heated to a temperature of about 200 degrees (Fahrenheit) for

an hour or more, until the hot liquid has penetrated half an inch or so, enough to expel much of the air and moisture within the wood. The time required varies depending upon the kind of wood used. The posts are then removed and immersed in a similar tank of cool creosote, where the contraction draws the oil further into the wood. If just a few posts are to be treated, only one tank may be used by withdrawing the fire and allowing the wood and creosote to cool together. The metal drums of 40 or 50 gallons capacity, in which creosote is sometimes sold, make good treating tanks.

A more simple method is to paint the post butts with several coats of hot creosote, although this method is not so satisfactory as the hot bath treatment, because sufficient penetration is not obtained. It may be used for preserving barn flooring, sills, and heavy timber that cannot be handled readily in tanks.

Miscellaneous Products.—There are many other uses for our native woods which offer profitable markets for forest products in certain localities. The rustic furniture industry uses considerable quantities of small red and white cedar poles. The same species are desired for bean poles, grape stakes, oyster stakes and dye sticks. Boat fenders, made of green hardwood poles usually 5 to 8 feet long and from 5 to 9 inches in diameter, are used quite extensively. There is also some demand for naturally crooked oak pieces as ship knees for the prowes of small boats. Dunnage wood, cut in 2-foot lengths, used for packing ships cargoes, is occasionally a profitable way to dispose of pine suitable only for cordwood. Hickory, oak and ash plank or billets find a ready sale to manufacturers of tool handles and vehicle parts. Apple wood is used by the manufacturers of saw handles. Turning mills offer good markets for special woods. Very hard woods, such as dogwood and persimmon, are made into wooden bearings, shuttles and similar products. These are but a few of the special uses which frequently enable a woodland owner to dispose of his timber with the greatest profit. Specifications and prices can be obtained from manufacturers and buyers.

TIMBER ESTIMATING

An owner intending to cut or sell his timber should first estimate how much and what kinds he has to dispose of or use. This is especially important if he contemplates selling standing timber or stumpage. To estimate a tract of timber is to determine, as accurately as may be desirable, the contents of the trees standing within the given area, in terms of the products desired. For instance, a tract may be estimated to contain sawlogs yielding so many thousand board feet of lumber, or so many poles, ties, fence posts, cords of wood, etc.

Many experienced woodsmen can determine fairly well the amount of timber within a tract simply by looking it over more or less carefully. When timber was abundant and cheap this method was good enough, but today it will hardly suffice. As timber increases in value, more careful estimates are desired. It is usually advisable to measure the diameter and height of the trees, and determine their contents from prepared volume tables, as explained later on pages 79 to 81. If the tract is small, or the timber valuable enough to justify the most accurate estimate possible, all the trees should be measured. If this is not considered necessary or if the tract is so large that a complete estimate is not practicable, the trees on certain sample portions of the tract may be measured, and from them the volume of the entire area may be computed. There are two methods commonly used, the "sample plot" and the "strip" method.

Sample plots are selected in portions of the tract where conditions are average, and all the trees within these plots are measured, so that their volume may be calculated. Knowing the number of sample plots and the area of each, as well as the area of the entire tract, it is a simple matter to figure the stand per acre and the volume of the entire stand. Usually a one-quarter acre sample plot is preferred,

which may be a circle with a 59 foot radius, or a square 104 feet on a side. If necessary, the boundaries of these plots may be marked with crayon on the trees, with light bark blazes or with stakes.

It is most important that the sample plots represent average timber conditions, if an accurate estimate is to be had. On small tracts where the size, density and condition of the timber is uniform, accurate work is easier than where there is considerable variation within the tract. Each sample plot should represent average conditions for a definite and known area of similar timber. At least one quarter-acre plot for each 5 acres of timber should be measured.

The strip method of timber estimating is commonly used on large tracts, especially when it is desirable to make a survey and map of the tract at the same time. It consists of measuring trees on narrow strips, usually one chain wide (4 rods or 66 feet) distributed systematically over the forest and covering, in the aggregate, a specified portion of the total area. Ten square chains, or a strip 10 chains long and one chain wide, equals an acre. A strip estimate requires a crew of two or three men, one to run the line of the strip with a compass, and to tally the trees measured by the others. The strips should be so planned that they represent the average timber conditions of the tract. For instance, if a square 40 acre tract of timber (20 chains on a side) contained some scattered and scrubby timber running north and south through the center of the tract, the estimate strips should be run east and west, so that each strip would contain the average amount of good and poor timber. On a tract of this size and shape, 4 strips 1 chain wide running across the tract at intervals, would include 80 square chains, 8 acres, or 20 per cent of the entire area. From this the contents of the entire stand may be readily calculated

Ordinarily the sample plot method will be found most satisfactory in small woodlots for inexperienced estimators.

MEASURING TREES

After deciding whether the estimate is to be based on a measurement of all the trees within the tract, or of those within sample plots, it is necessary to count and measure the size of the trees within the selected areas. The diameter, height and species of every tree should be recorded.

Diameter.—Many lumbermen use the diameter at the top of the stump as the diameter of the tree, but this is unsatisfactory because stump heights vary, and because there is usually a considerable swell at the base which varies greatly in trees of the same general size. Diameter breast-high (called D. B. H.) 4½ feet above the ground,, is convenient for measurement, avoids these objections, and is always used by foresters where diameter measurements of trees are required.

An ordinary ruler or yard stick held against the tree parallel to the line of its diameter will enable a person to estimate the diameter fairly well. For more accurate work tree calipers are most convenient. They consist of a stick usually 36 inches long graduated into inches and fractions of inches. At one end is a rigid arm set at right angles to the stick, while a similar arm is so fixed that it will slide back and forth at will. A pair of calipers can be easily made, although its accuracy depends upon the movable arm always remaining at right angles to the graduated base, and parallel to the rigid arm. If a tree is not exactly round both its largest and smallest diameters should be measured and the average between these diameters accepted as the true diameter. A diameter tape is sometimes used, where great accuracy is desired. The tape is passed around the tree at the proper point and the diameter read from the tape, since it varies directly with the circumference.

Height.—In order to compute the contents of a tree, it is necessary to measure its height as well as diameter. When the entire contents of the tree are desired, including the cordwood in the limbs, the total height is usually measured. When the volume of the tree in terms of sawlogs, poles, ties, etc., is desired, the merchantable height, or length of the usable portion of the trunk, is measured. If logs can be sawed down to 4 inches at the small end, then the merchantable height of the tree

would be the distance from the stump up to the point where the tree measures just 4 inches in diameter.

Where the trees average about the same height throughout the stand, it is often sufficient to use the height of a few typical trees as average for all. Where trees of all sizes are found, they can often be grouped into three or four height classes, accurate enough for practical purposes. For instance, trees from 4 to 6 inches in diameter, 40 feet tall; 7-10 inches, 50 feet; 11-14 inches, 60 feet; 15-18 inches, 70 feet; etc

The simplest way of getting the height of a stand is to cut down a few average trees and measure them with a tape. Where this is not advisable, fallen trees can often be found on the ground. Another method fairly accurate on level ground is to measure the length of a tree's shadow and compare it with the shadow of an object of known length. For instance, if an upright stick 6 feet long casts a shadow 8 feet long, and the tree's shadow is 90 feet long, then, by direct proportion

6 is to 8 as X is to 90

$8\ X = 540$

$X = 67\frac{1}{2}$ feet, height of the tree.

Another method, fairly accurate for persons who can judge distance well, is to place a 10 foot pole beside the tree, stand back where the entire tree can be seen readily, and estimate how many 10 poles, one over the other, would be required to reach the top of the tree, or the point to which the height is desired.

Any instrument that reads angles, a measuring tape and the application of trigonometry also gives the desired results. Hypsometers of several types, constructed to give direct readings of height, are also to be had.

Recording Measurements.—For the sake of accuracy and convenience, an estimate should record measurements of trees by species. The following tally is most convenient:

NUMBER OF TREES PER ACRE

Height	Diameter D. B. H.	White Oak	Red Oak	Hickory	Maple	Miscellaneous
40′	4″	14	9	2	19	4
	5″	17	16	5	26	6
50′	6″	25	31	9	14	3
	7″	18	26	6	7	1
60′	8″	11	14	4	0	0
	9″	7	11	1	0	0
	10″	3	8	2	0	0
	Total	95	115	29	66	14

COMPUTING THE CONTENTS OF TREES

Having recorded the number of trees of various sizes on the area, the volume of each is found in a volume table, and the total contents determined by multiplying by the number of trees of each size and summing up the total.

Volume tables give the contents of normal trees of various sizes, and are made from careful measurements of average trees. When the diameter and height (either total height or used length) of a tree are known, volume tables give the contents of average trees of like dimensions. The volume may be expressed in board feet, cubic feet, cords,—or in the number of posts, ties, etc., for each tree.

Volume tables are ordinarily made for one species only, because the form, taper, shape and crown contents of different species vary, and with these variations, the contents of the tree. Where exact results are neither expected nor desired, a volume table for one species will give approximately correct results for other species of similar form of growth.

The following volume tables represent several types which may be useful to woodland owners desiring to estimate their timber.

VOLUME TABLES

RED OAK (a)

Diameter Breast-High (inches)	Length of Tree Used (Feet) 10′	20′	30′	40′	50′
	Volume in board feet of sawed lumber (b)				
5″	6				
6″	9	15			
7″	14	22	29	34	
8″	18	30	39	43	
9″	25	40	49	58	
10″	31	50	60	73	99
11″	37	63	74	90	118
12″	44	78	89	110	143
13″	54	93	107	132	174
14″	65	109	126	160	208
15″		124	149	190	243
16″		143	173	225	288
17″		163	201	262	330
18″		181	232	308	378
19″		202	265	356	428
20″				405	478

(a) Table from U. S. Forest Service Bulletin 36, "The Woodman's Handbook".
(b) Actual mill-cut in untrimmed inch boards.
This table will give fairly accurate results for other hardwoods such as white oak, hickory, ash, etc.

SMALL, SECOND-GROWTH HARDWOODS (a)

Diameter Breast-High (inches)	Total Height of Tree (Feet). 20′	30′	40′	50′	60′
	Volume of cordwood in cubic feet (b)				
2″	0.2	0.5			
3″	0.5	0.8	1.1		
4″	0.9	1.4	1.8		
5″		2.3	2.7	3.2	
6″		3.4	4.0	4.8	5.7
7″		4.8	5.7	6.6	7.9
8″			7.7	9.0	10.6
9″				11.8	13.6
10″				15.3	17.3
11″				19.6	22.6
12″				24.6	28.0
13″					32.2

(a) Table from U. S. Forest Service Bulletin 36, "The Woodsman's Handbook".
(b) This table, based upon the measurement of white oak, may be used for other second growth hardwoods to be cut into cordwood, down to sticks (limbs) 1 inch in diameter. A cord made up of mixed diameters of second growth wood is considered to contain 80 cubic feet of solid wood, and this table can be reduced to cords by dividing by 80. Experience has shown that where very small trees are cut, ranging from 2 to 6 inches in diameter, the contents of a piled cord of wood may be as low as 65 cubic feet.

SHORTLEAF PINE (a)

Diameter Breast-High (inches)	Total Height of Tree. (Feet) 50′	60′	70′	80′
	Volume in board feet by the Scribner Log Rule.			
9″	40	50	60	
10″	45	60	80	95
11″	50	70	95	115
12″	65	90	110	135
13″		105	135	160
14″		130	160	190
15″		160	190	220
16″			225	260
17″			260	300
18″			300	345
19″			345	395
20″				450
21″				505
22″				570

(a) Table from U. S. Forest Service Bulletin 36, "The Woodsman's Handbook". This table is based on measurements of shortleaf pine, but will give fairly accurate results for other South Jersey pines such as pitch pine and scrub pine, where the trees are of good form and height. This table will not give accurate results for low, scrubby timber. In that case probably the best way to compute the contents of a tree is to estimate the number and size of the logs which could be cut, and get their volume by the use of a log rule, such as that described on page 83. For instance, a tree 35 feet tall with a D. B. H. of 14 inches will probably cut a butt log 12 feet long with a top diameter of 10 inches and a top log 12 feet long, 6 inches at the small end. Scribner's log rule gives the contents of such logs as 40 board feet and 12 board feet respectively, or a total of 52 board feet for the tree.

PINE CORDWOOD (a)

Diameter Breast-High (inches)	Total Height of Tree (Feet) 20′	30′	40′	50′	60′	70′
	Volume of entire tree in cubic feet (b)					
2″	0.3					
3″	0.6	0 9	1.2			
4″		1.5	2.0	2.4		
5″		2.2	2.9	3.6		
6″			4.2	5.2	6.3	
7″			5.7	7.2	8.7	10.2
8″			7.5	9.4	11 3	13.1
9″				11.6	13.9	16.2
10″				14.1	16.6	19.2
11″				16.8	19.6	22.5
12″					22.6	25.7

(a) Table from U. S. Forest Service Bulletin 36, "The Woodsman's Handbook", based on measurements of scrub pine.

(b) This table will give fairly accurate measurements for native Jersey pines cut into cordwood, pulpwood or charcoal wood. To reduce cubic feet to cords of peeled pulpwood, divide by 110. To reduce to cords of unpeeled charcoal wood or cordwood (down to 2″) divide by 100, or by 80 if small trees only (less than 6 inches B. B. H.) are used.

UNITS OF MEASURE—CONVERTING FACTORS

There are many units of measure used in expressing the volume or contents of a tree, log, or stick of timber, varying according to products and local practise. It is important to know just what these various units of measure are, and their relation to each other, or the "converting factors".

Board Measure.—Board measure is designed primarily for the measurement of sawed lumber. The unit is the board foot, which is a board 1 inch thick and 1 foot square, or its equivalent. For example, an inch board 12 inches wide and 16 feet long contains 16 board feet; an inch board 9 inches wide and 16 feet long contains 12 board feet; a 2-inch plank 9″x16′ contains 24 board feet. Although not strictly accurate, the lumber trade usually figures boards under 1 inch in thickness as inch lumber. Lumber is sold in large quantities by the thousand board foot measure—M. B. M.

Log Measure.—The volume of sawlogs is usually measured and expressed in the number of board feet of lumber they will actually cut, allowing for waste in slabs, sawdust, etc. Log rules give the board foot contents of logs, based upon their length and the diameter of the small end inside the bark. The amount of lumber which can be cut from logs of a given size is not uniform, because the factors which determine the amount of waste vary under different circumstances, such as the thickness of the saw, the thickness of the boards, the size of the smallest board which may be utilized, the skill of the sawyer, the efficiency of the machinery, the defects in the log, etc. This lack of uniformity has led to wide differences of opinion as to how log rules should be constructed. There are many log rules in use, some more accurate than others, and unfortunately some of the most inaccurate are most popular with lumbermen. For example, the Doyle rule is commonly used in New Jersey, and is in favor with many lumbermen who buy timber because it gives a very low estimate for small logs, although fairly accurate for large sized timber. The Scribner log rule will ordinarily give a more accurate measure for logs below 28 inches in diameter and should be more generally used.

COMPARISON OF DOYLE AND SCRIBNER LOG RULES

Contents of 16-foot logs in board feet for different diameters.

	Diameter of log in inches at small end.									
	6″	8″	10″	12″	16″	20″	24″	28″	32″	36″
Scribner	18	32	54	79	159	280	404	582	736	923
Doyle	4	16	36	64	144	256	400	576	784	1024

The diameter of logs is always measured at the small end inside the bark, since this limits the width of the boards. The scaler must make allowance for defects such as decay, crooks, etc. Log rules may be used in a rough estimate of standing timber by estimating the number and size of the logs in a tree, the contents of which may be determined from the log rule.

SCRIBNER LOG RULE

Contents of Average Logs in Board Feet.

Diameter of log at small end (inches)	Length of Log (Feet)						
	8′	10′	12′	14′	16′	18′	20′
6″	8	10	12	14	18	22	24
7″	12	15	18	24	28	32	34
8″	16	20	24	28	32	40	44
9″	20	25	30	35	40	45	50
10″	27	34	40	45	50	55	65
11″	33	42	50	55	65	70	80
12″	39	49	59	69	79	88	98
13″	48	61	73	85	97	109	122
14″	57	72	86	100	114	129	143
15″	71	89	107	125	142	160	178
16″	79	98	119	139	159	178	198
17″	92	116	139	162	185	208	232
18″	106	134	160	187	213	240	267
19″	120	150	180	210	240	270	300
20″	140	175	210	245	280	315	350
21″	152	190	228	266	304	342	380
22″	167	209	251	292	334	376	418
23″	188	236	283	330	377	424	470
24″	202	252	303	353	404	454	505
25″	229	287	344	401	459	516	573
26″	250	312	375	439	500	562	625
27″	271	342	411	479	548	616	684
28″	291	363	436	509	582	654	728
30″			493	575	657	739	821
32″			552	644	736	828	920
34″			600	700	800	900	1000
36″			692	807	923	1038	1152

Cord Measure.—Fuel wood, pulpwood, and material cut into short sticks for various uses is usually measured by the cord. A standard cord is 128 cubic feet of stacked wood, usually a pile of 4-foot wood stacked 4 feet high and 8 feet long. As a matter of fact a piled cord of wood 4′x4′x8′ does not actually contain 128 cubic feet of solid wood because of the air space between the sticks. Other things being equal, the larger and more symmetrical the sticks, the greater the quantity of solid wood. A cord of straight, round 6″-10″ bolts of pulp wood piled closely may contain 90 to 110 cubic feet of wood, whereas a cord of fuel wood, consisting of split wood and small limbs, loosely piled, may contain as little as 65 or 70 cubic feet. Under average conditions a cord of wood is assumed to contain 80 cubic feet of wood, or 500 board feet, if expressed in the equivalent of sawed lumber. A pile of stove wood cut into 16-inch lengths, 4 feet high and 8 feet long, is often sold as a cord, although actually it contains only one-third of a cord.

Cubic Measure—A cubic foot of wood is a block 12″x12″x12″, or its equivalent. A cubic foot of wood could be split into 12 board feet, but if sawed into inch boards with a saw ¼″ thick (kerf), would actually yield 9.6 board feet. Some volume tables express the contents of a tree in cubic feet, which may be converted into the number of board feet, cords, or products desired. As a unit for expressing the contents of a tree, the cubic foot is more accurate than the cord, because air space, which varies greatly, must always be considered in cord measure.

CONVERTING FACTORS

The following list of wood equivalents or converting factors are those commonly accepted in this region, and will help anyone determine the approximate contents of piles or pieces of timber.

Products.	Equivalent in Board Feet.	Assumed Dimensions.
Cord (Shingle Bolts)	600	4′ x 4′ x8′
Cord (fuel)	500	4′ x 4′ x8′
Pole (electric)	60	7″x30′
Pole (electric)	100	9″x30′
Tie (standard)	42	7″x9″x8½′
Tie (standard)	33	6″x8″x8′
Tie (second)	28	6″x7″x8′
Tie (narrow gage)	21	6″x7″x6′
Pole (fence)	10	4″x20′
Post (fence)	7	6″x 7′

The following table indicates approximately the number of average trees of any diameter required to yield one thousand board feet of lumber or one cord of wood.

NUMBER OF AVERAGE TREES OF EACH SIZE TO YIELD—

Diameter of Tree D. B. H.	ONE CORD		1000 BOARD FEET OF LUMBER	
(Inches)	Hardwoods	Pine	Hardwoods (a)	Pine
4″	50	70		
5″	30	45		
6″	20	30	65	50
7″	15	20	50	35
8″	10	13	35	25
9″	7	10	25	20
10″	5	8	20	16
11″	4	7	16	13
12″	3.5	6	12	10
13″	3.0	4.5	10	7
14″	2.7	3.7	9	6
15″	2.5	3.0	8	5
16″	2.0	2.5	7	4
17″	1.7	2.1	6	3.1
18″	1.5	1.9	5	2.6
19″	1.3	1.6	4	2.4
20″	1.2	1.5	3.5	2.1
21″	1.0	1.4	3.1	1.8
22″	.9	1.2	2.7	1.7
23″	.8	1.1	2 3	1.6
24″	.7	1.0	2.0	1.5

Part of table taken from U. S. F. S. (Farmer's Bulletin 1210).

(a) For every 1000 feet of lumber, about 2/3 of a cord of wood can also be cut from the tops.

TREE PESTS

Ordinarily trees or woods in thrifty condition are little harmed by attacks of insects or fungus diseases. Dead, dying and weakened trees breed injurious pests. Therefore, the best protection is to keep the trees growing vigorously, and remove the dead or weakened individuals.

Of course there are exceptions. Occasionally a new insect or disease is introduced which does great damage even in healthy timber before control measures can be adopted, or before the trees develop some degree of immunity. The chestnut blight is an example of a new fungus disease which did, and is continuing to do, untold damage to the chestnut trees of this country. The very nature of this fungus growth, which develops beneath the bark of the tree and spreads by means of minute spores carried by the wind, insects, birds and squirrels, makes it impossible for man to control or prevent its spreading. In time the chestnut may develop some immunity from this fungus, at least enough to survive its attack, but as yet there is no direct evidence that such will be the case.

An insect or fungus disease is commonly most injurious to a single tree species. For instance, the chestnut blight affects only chestnuts, the white pine weevil and the blister rust disease attack only the white (5-needle) pines. Defoliating worms like the larvae of the Gipsy moth, recently discovered in Somerset County, sometimes attack all kinds of trees.

A new pest recently introduced is most serious for a time until nature has had a chance to reestablish a balance. This she does by developing natural enemies to keep the tree pests in check. Importing plants from foreign lands has been responsible for most serious attacks within late years.

In the case of shade or ornamental trees most insects and many diseases can be controlled or prevented by spraying or other special care, but in the case of forest trees such intensive measures are usually too expensive to be practical.

Remember that thrifty, vigorous trees suffer least from insects or diseases. Information regarding the habits, damage and control of injurious insects may be had upon request to the State Entomologist, New Brunswick, N. J. The State Plant Pathologist at New Brunswick will furnish similar information regarding fungus diseases of trees. Specimens of the pests and samples of their work should accompany requests for information.

FOREST FIRES

must be controlled. They are the forests' worst enemy, and unless they are materially reduced in numbers and size the threatened timber shortage will soon become a reality. Remember that the first step in Forestry is protection from fire. Do your part and encourage your neighbor to do his. Let's get together and help—

"MAKE NEW JERSEY SAFE FOR FORESTRY"

BEERS PRESS, INC., TRENTON, N. J.

LIBRARY OF CONGRESS
0 002 818 621 6